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SCIENCE

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

BOTANY IN RELATION TO AGRICULTURE[1]

IT is the aim of this discussion not merely to show the relation of botany to agriculture, but also to point out on the one hand what botanical investigation has actually done for American agriculture, and on the other, how recent agricultural development has stimulated the science of botany along both educational and investigational lines.

Though much of its practical application passes under such titles as agronomy, horticulture, animal and dairy industry, and soil technology, scientific agriculture depends primarily upon the three fundamental sciences of chemistry, zoology and botany. Of these, botany should and does have the closest relationship with it. This is indicated by the fact that out of 5,500 persons concerned with agricultural teaching and investigation in the U. S. Department of Agriculture and the various agricultural colleges and stations, about 700, or 12 per cent., may be classified as botanists.

There are botanists, however, who are so engrossed in the pure science of their subject that they have little interest in its economic, or, what to-day is almost the same thing, its agricultural relation; on the other hand, there are those working on the practical side who do not appreciate how much the pure science of botany has aided them in their work. We have no quarrel

[1] Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, Columbus, December, 1915.

with the former, for whether they realize it or not, all scientific discovery has its ultimate practical bearing. Neither have we any apologies to offer for the so-called practical botanists, for they are the botanists of to-day in the United States, as shown by number of positions occupied and of articles published.

What, then, of this agricultural botany and the factors concerned in its development? Let us first take a brief glance at the closely related subject of the development of agriculture.

AGRICULTURAL DEVELOPMENT

Early History.—Agriculture is unquestionably a fundamental factor in the growth of a nation, therefore as a practise it goes back to the time when men first banded together into societies. But real scientific agriculture, especially as an educational movement in our colleges, is of comparatively recent origin, even more recent than that of botany. Its first educational agencies in this country were a few agricultural periodicals and the various agricultural, horticultural and allied societies that were organized to meet the demands of their time and locality. Schools of agriculture were lacking, and even instruction in existing educational institutions was not provided. Apparently the first or one of the first agricultural schools was that established by the Golds, father and son, at Cream Hill, Connecticut, in 1845, and continued until 1869. About the time of the founding of this school, Norton was appointed professor of agricultural chemistry at Yale, and among his early students were Brewer, the agriculturist, and Johnson, the chemist, both of whom later played such a prominent part in the development of our scientific agriculture. The Bussey Institution of Harvard, although provided for many years previously, did not begin its agricultural work until 1870; but in its earlier publications appeared the investigations of Storer in agricultural chemistry, the work of Farlow with plant diseases and that of Sargent in the Arnold Arboretum. In 1875 Hilgard began his work in California, and in 1880, Henry, in Wisconsin. All of these men were either directly or indirectly interested in botany.

Agricultural Colleges.—The first important factor in this agricultural development, however, was the Morrill Land Grant Act, signed by President Lincoln in 1862, which during the next few years resulted in the founding of our various state universities and agricultural colleges. To-day each state has its university or its agricultural college well established, and many states have both, either as separate or united institutions. Several of the Southern States also have somewhat similar schools of agriculture for their colored population. The various states have backed these institutions with financial aid which now in many cases exceeds that given by the government. For example, one state in its recent biennial appropriations gave to its state university, which includes the agricultural college, five million dollars.

Our agricultural colleges now compare very favorably with those of engineering and arts and science in number of students, professors and courses given. Yet twenty-five years ago they had few students, and a professor of agriculture, another of horticulture, and one of veterinary science, together with the professors of botany, zoology and chemistry as associates, often constituted the entire agricultural faculty. What a contrast to the agricultural staff of to-day, which often exceeds a hundred members, as at the University of California, with 145, Iowa State College with 213, Michigan Agricultural College with 109, Cornell with 189, Massachusetts Agricultural College with 82, and other agricultural colleges with numbers in proportion to the

agricultural development of their respective states. And what a variety of titles these educators bear! The old professors of agriculture, horticulture and botany have been largely replaced by professors of agronomy, dairy industry, animal husbandry, genetics, enology, citriculture, landscape gardening, pomology, olericulture, forestry, bacteriology, plant pathology and a score or so more.

Department of Agriculture.—The second great influence in the development of scientific agriculture in this country was the establishment by Act of Congress, in February, 1889, of a department of agriculture at Washington, and the appointment of J. M. Rusk as its first secretary in the President's cabinet. Since 1862, however, there had been a commissioner of agriculture, and there were already several bureaus or divisions. Even before this for years there had been issued from the Patent Office reports dealing with agricultural information. To-day the department of agriculture comprises, besides various minor groups, bureaus of weather, animal industry, plant industry, chemistry, soils, entomology, biological survey, crop estimates, services of forest and of states relations, and offices of markets and rural organizations and of public roads and rural engineering. To carry on the work of the department, there were in 1913 nearly 15,000 employees, and the annual appropriation was $18,000,000.

Agricultural Experiment Stations.—The third factor in our agricultural development was the establishment of the agricultural experiment stations through the passage of the Hatch Act by Congress in 1886. Even previous to this, there had existed several state stations, that at New Haven, Conn., established in July, 1877, being the first. Each state originally received $15,000 a year from the government, but some years ago this was increased by the Adams Act an additional $15,000, which goes to support the more strictly scientific work. At present most of the stations also receive state aid, which in some cases greatly exceeds that given by the government. For instance, in 1913 the total revenue of the fifty-seven stations in this country was over $4,650,000, and in the case of two of these it reached nearly half a million.

Some idea of the number of investigators employed in stations having no college affiliation is shown by the Ohio station roll, with 64, the Geneva station with 37, and the Connecticut station with 25. Of the stations connected with colleges, California has a staff of 67 employed all or a part of the time in station work, Illinois 88, Wisconsin 84, Kansas 66, and Pennsylvania 49. The literature already issued by the various stations requires one hundred feet of library shelves to hold it, making by itself a very respectable working library in agriculture.

One of the important results of the establishment of experiment stations was the stimulating effect on both the agricultural colleges and the Department of Agriculture. Up to that time the colleges, as a rule, had not taught much agriculture because they had few students; and the department had not yet begun to do much investigational work. By furnishing positions for the agricultural colleges to fill, and by bringing them into closer touch with the farmers, the number of students has been greatly increased and the standing of the colleges much improved; while the rivalry in investigational work between the stations and the department has been of mutual advantage.

Agricultural Extension.—A fourth factor that may greatly influence agriculture in the future is the establishment of the agricultural extension movement, through the Smith-Lever bill, passed by Congress in

May, 1914. One of its chief features, besides the state organization, affiliated with its agricultural college, to direct the work, is the organization of societies in the various counties, with a paid Farm Bureau agent, who shall carry direct to the farmers for practical application the teachings of the agricultural colleges and the results of the investigations of the Department of Agriculture and the experiment stations.

Whether or not this extension service will prove as valuable as have the colleges and stations remains yet to be demonstrated, but it is based in part on results already accomplished in the south. The government has backed the movement with an appropriation of $10,000 a year to each state, this to be gradually increased in proportion to the agricultural population, provided equal sums are appropriated by the state. This means that by the year 1923 there may be spent in this work in the United States over $9,000,000. In most states this will be more money than is spent by the experiment station, and in a few possibly more than is spent by the agricultural college.

BOTANICAL DEVELOPMENT

Early History.—I have gone thus fully into the history of American agriculture because I believe that botany, at least during recent years, has been fundamentally influenced by it. What has been the history of our botanical development? It began with the explorers, usually foreigners, who collected plants and sent them to Europe for identification and description. Then came our native collectors, who finally began to describe the plants they collected. These early workers were interested chiefly in flowering plants, but occasionally there was an individual who worked with fungi or other groups. Local natural history societies in time offered congenial atmosphere for the study of local floras. Eventually governmental aid was given to exploring expeditions. Usually those engaged in botanical work were men who gained their livelihood from some other profession,—doctors, ministers and even lawyers.

First College Instruction.—There were a few institutions, however, that quite early had professors who gave limited botanical instruction and carried on investigations. Some idea of this early botanical work is given by the following notes from five of our oldest educational institutions, furnished the writer by their present botanical heads.

At Harvard, our oldest educational institution, William Dandridge Peck was appointed Massachusetts Professor of Natural History in 1805, and was the founder of the present Gray Botanical Garden. He was both a zoologist and a botanist, and gave lectures in the university. Peck was succeeded in 1825 by Thomas Nuttall, who was director of the botanical garden and lecturer in natural history. Nuttall lived at the Garden, but evidently did not greatly relish his work, as he resigned in 1834. In 1842 the Fischer Professorship of Natural History was founded, and Asa Gray was appointed. This professorship has been since its foundation a botanical position, a fact worthy of mention to our zoological friends, who in these days seem to dominate all the professorships in biology.

At Yale, botany was apparently first taught to a greater or less extent by Dr. Eli Ives, who held a position in materia medica and botany from 1813 to 1829, and a professorship in theory and practise of physic until 1852. He established a small botanical garden, which has since gone out of existence. After Ives's time botanical instruction was lacking until Daniel C. Eaton was appointed professor of botany in 1864, a position he occupied until his death in 1895.

At Princeton, the first instruction in bot-

any was probably given in the closing years of the eighteenth century, by John Maclean, who was professor of chemistry and natural history. From 1824 to 1829 Luther Halsey was professor of natural philosophy, chemistry and natural history, and from 1830 to 1854 a similar position was held by John Torrey. In 1874 George Macloskie was appointed professor of natural history, and still occupies the chair of biology as professor emeritus. It was not until a few years ago, however, that one man, Professor Rankin, gave all his time to botany, and only very recently that Shull was appointed as the first professor of botany and genetics.

So far as shown by the actual dates given me, Columbia was the first institution where botany was taught, since Daniel Treadwell was professor of natural history at Kings College from 1757 to 1760. The first professor of botany was Richard Sharpe Kissam, 1792, who was succeeded by Samuel L. Mitchill, 1793 to 1795. After that botany was apparently included under natural history until the time of Dr. Torrey, who was professor of chemistry and botany, and apparently the real founder of the science at that institution.

According to both Farlow and Harshberger, the University of Pennsylvania can claim the first real botanical professorship in this country, as Dr. Adam Kuhn was made professor of botany and materia medica in 1768. Later William Bartram was appointed to the same chair, but did not accept.

Recent Development in Colleges.—Practically all this early instruction was limited to a systematic and a morphological study of the phanerogams. Apparently it had little or no relation to agriculture, its aim being purely scientific and educational, not practical. Modern botanical instruction, so far as a single institution can illustrate it, began at Harvard in the early 70's, when, under Gray, opportunity was provided for Goodale's work in vegetable physiology and Farlow's in cryptogamic botany.

About this time, however, the establishment of state universities and agricultural colleges formed a potent agency in the development of modern botanical education; for just as surely as these have been prime factors in the progress of modern agriculture, so have they been in the growth of modern botany, at least in its economic aspects. Among the names associated with this pioneer period are those of Farlow, whose early work at the Bussey Institution was of an agricultural nature, Beal, at the Michigan Agricultural College, Burrill, at the University of Illinois, Bessey, at the Iowa Agricultural College, and later at Nebraska University, Tracy, at the University of Missouri, Havey, at Maine, and a few others.

To-day there are approximately three hundred teachers and investigators carrying on this work in our agricultural colleges and stations; while there are perhaps an equal number engaged in botanical work in the universities outside of agricultural colleges, and in other non-agricultural institutions. These, with the four hundred in the Bureau of Plant Industry at Washington, make about one thousand persons in this country engaged in advanced botanical work as a profession.

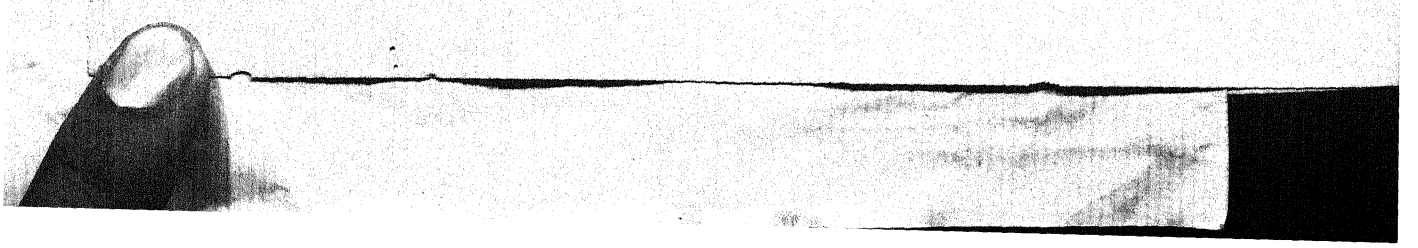
In order to gain some idea of the number of general and special students in botany, and the courses offered in the agricultural colleges as compared with those in non-agricultural institutions (including those where botanical instruction in the university is separate from that in the agricultural college), the writer recently sent out a short questionnaire to an equal number of agricultural and non-agricultural institutions, and received replies from 41 of the

former and 38 of the latter. No doubt these questions were not always answered from the same point of view, but including such possible discrepancies, they show the following results:

Total attendance at reporting agricultural institutions, 62,049; non-agricultural, 70,000; an average number per institution of 1,513 and 1,842, respectively. Number of students taking some work in botany the past year, in the former 12,594, in the latter 6,354, or average numbers per institution of 307 and 167. This means that about 20 per cent. of the students in agricultural institutions took some form of botany as compared with 9 per cent. in the non-agricultural. Number of major students in botany, for the former 391, as compared with 386 for the latter, making an average per institution of 10 in each case. Number of postgraduate students doing botanical work in the agricultural colleges, 180, in the non-agricultural, 228, or an average per institution of 4 and 6, respectively. Total number of botanical courses offered, in the former 537, in the latter 336, or an average per institution of 13 and 9, respectively. Of the 41 agricultural colleges, 32 had one hundred or more students taking some work in botany, while of the 38 non-agricultural there were but 16 with this number. There were 26 of these agricultural colleges that offered 10 or more courses in botany, as compared with 14 non-agricultural; and there were 13 of the former that reported 5 or more postgraduate students as compared with 9 of the latter. In total number of postgraduate students in botany, however, the non-agricultural colleges led, due to the large number at the University of Chicago, which was responsible for 103 of the 228 reported.

Admitting that these figures, like figures in general, probably lie, still we believe that from them and the data that accompanied them certain general conclusions can be drawn, as follows: (1) That, per institution and as a whole, the number of undergraduates taking botany in our American universities and colleges is greatly in favor of the agricultural institutions. (2) That the number of students in the latter pursuing advanced and postgraduate work, however, is not any greater. (3) That the variety and number of courses offered considerably exceed that of the non-agricultural. (4) That there are a number of our non-agricultural universities that in equipment, instructional force, and courses given in the pure science of botany offer advantages equal to or better than those in the best of the agricultural institutions.

The reasons for the conditions indicated by these conclusions are: (1) That, because of its affiliation with agriculture, botany in some form is favored or required in many of the agricultural colleges; while in the non-agricultural it is generally optional, and in a number of the smaller eastern colleges is not even offered as a distinct course, being given only under "biology." The inclusion under botany of bacteriology, plant breeding and forestry, or the very close connection where these subjects have been split off from this science, and the more distant, but still distinct connection with agronomy, horticulture in all its lines and entomology, are secondary factors in furnishing in the agricultural colleges numerous students who must have some instruction in botany, and from widely different points of view, thus developing numerous courses. Finally, the chances of landing a botanical position, aside from those in high schools and the limited number in non-agricultural institutions, are greatly in favor of the man who has had at least undergraduate training in the agricultural college, since he has open to him the numerous places in these institutions, their experiment stations and



the Department of Agriculture; or if he merely takes minor work in botany, and specializes in some other line of agriculture, there are open the countless positions in these allied branches, including those of the newly established Farm Bureau work.

Department of Agriculture Botany.—Turning now from the botany in our agricultural colleges to that in the U. S. Department of Agriculture, what can we say of its development and influence? It apparently had its beginnings in the Patent Office Reports and the plant collections that were deposited with the Smithsonian Institution from time to time, chiefly by the various governmental exploring expeditions in the far west. As a distinct division, it was established soon after the completion of the department building in 1868, when it was found necessary to have a botanist to complete the working force, which at that time included among others a chemist and an entomologist.

C. C. Parry was apparently the first botanist, and he wrote in his report for 1869 as follows:

> In entering upon the duties of botanist to the Department of Agriculture in March, 1869, my first care was directed to the arrangement of the large and valuable collections of dried plants received from the Smithsonian Institute.

In April, 1872, George Vasey became the botanist, and, like Parry, his time at first was largely taken up with herbarium duties. Vasey, however, soon began to publish articles dealing with flowering plants, partly from a systematic point of view, though economic studies of the grasses, of weeds, and of medicinal and poisonous plants were also made.

Although as early as 1871 Thomas Taylor, the microscopist of the department, had written articles concerning various diseases of plants caused by fungi, and even such obscure troubles as peach yellows, it was not until 1886 that the Division of Botany established a distinct mycological section, with F. Lamson-Scribner in charge. The character of his report for this year forecasted the important place that this subject was to occupy in the future development of the department. That this new work met with the hearty approval of the country was shown by resolutions adopted by various societies and sent to the commissioner of agriculture, among which was one by the Botanical Club of America.

In 1888 B. T. Galloway was appointed chief of the Section of Vegetable Pathology and Physiology, and, with A. F. Woods as assistant, was intimately connected with its subsequent development. One of the most important of the results of the Galloway regime was the reorganizing in 1901 of all the divisions of the department dealing with plant life, save forestry alone, under the new Bureau of Plant Industry. These united divisions were those of botany, pathology and physiology, agronomy, pomology and the experiment gardens and grounds, and with these were later included the Arlington Experiment Farm and some other lines of work. So far as the writer knows, the Department of Agriculture is the only institution in the United States that has recognized botany in its broadest meaning, and kept under its wing all the practical branches that elsewhere assume entire independence, or even include botany as a part of their development.

To-day the Bureau of Plant Industry has on its staff over 400 investigators doing work in the 32 groups which are under its control. These groups include such varied investigations as fruit diseases, forest pathology, cotton and truck diseases, crop physiology, soil bacteriology, soil fertility, drugs and poisonous plants, grain standardization, cereals, corn, tobacco, agricultural technology, fiber plants, seed testing, forage

crops, economic and systematic botany, sugar beets, irrigation, horticulture and pomology, seed and plant introduction, etc.

One of the more recent duties of this Bureau in connection with that of entomology has been inspection work under the Federal Horticultural Law passed in 1912. This has to do with regulations, including quarantine, and inspections, to prevent the importation of injurious insects and diseases of foreign plants, and in certain cases, to limit the further spreading of those already here. Previous to this law such work had been largely restricted to local state inspection, having had its origin in the effort of certain states to limit the spread of the San José scale. This work has been, and still is, largely in the hands of the entomologists.

While botanists got a late start here, they seem to have been the chief factor in similar work in Europe, so that when a world's conference was recently called at Rome to consider the subject, it was termed a Phytopathological Congress. This nomenclature seems to have aroused certain American entomologists with fear that plant pathologists were running away with what they considered their special work. Howard voiced this sentiment a year ago in a paper before the entomologists, as follows:

> There is a tendency now to break into the solidarity of our branch of science and to unite us with the plant disease people under the term phytopathology in so far as insects affect plant life. . . . To combine them into one service would be impracticable except as work of a large agricultural institution. To combine them under one name in a branch of agricultural science is absurd!

Personally the writer believes this work is more botanical than entomological, since the hosts are plants and the pests also in part. However, the work is largely routine and semi-political, involving the passage of inspection laws and the asking for appropriations, and so is somewhat on a par with the fertilizer work of our chemical friends. Why not then allow the entomologists still to dominate in this work in America, as they seem eminently fitted for it, and thus allay their fears of being absorbed by the plant pathologists?

Experiment Station Botany.—Let us now consider briefly the third factor in our recent botanical development, namely, experiment station botany. In a sense this is Department of Agriculture botany locally applied. However, the station botanist is usually working on various botanical problems, while the government botanist is putting his whole time on a few allied problems. This becomes increasingly so as time goes on; therefore one may expect the station worker to be a somewhat broader botanist, and the government investigator more of a specialist. On the other hand, the latter often has a wide but limited knowledge of his problem over the whole country, while the former has a detailed and continuous experience in a limited region. Together these two types of investigators are able to furnish admirable solutions to most botanical problems.

To Arthur, apparently, belongs the honor of being the first station botanist, as he was botanist at the Geneva station in 1884, when he published, among other studies, his paper on pear blight; however, in 1883 Maynard, professor of botany and horticulture at the Massachusetts College, was head of the horticultural department of the Massachusetts station, and published some notes on plant diseases that year.

Most of the states, upon the establishment of their stations, merely employed the professor of botany already at work in the college, and we have mentioned the names of several. Others established botanical departments for the first time, or placed them on a more substantial footing, and to these there came sooner or later such men

as Halsted from Iowa to New Jersey, Thaxter to Connecticut, Atkinson to Alabama from South Carolina, Humphrey and later Stone, to Massachusetts, Chester to Delaware, Pammel to Iowa, Nelson to Wyoming, Bolley to North Dakota, Earl to Mississippi, Jones to Vermont, Selby to Ohio, Stewart to Geneva, N. Y., and Rolfs to Florida.

To-day the botanist is a fixture at practically all the stations. Naturally some stations have been more active than others along botanical lines, and these have, besides a chief botanist, several assistants, or the work is divided into botany, plant pathology and plant breeding. For example, there are listed a dozen such investigators at the California station, and Cornell has eleven who give all or part of their time to station work; while at the Ohio station there are seven who give all their time.

Naturally one expects the station botanist to be primarily an investigator. In practise, however, he is handicapped by various other duties that limit his time for investigation. Usually he has more or less teaching to do. Then such routine work as extensive local correspondence, field, orchard and nursery inspection, demonstration tests, institute talks, and aid to state agricultural societies of various kinds, adds to his duties.

Despite these limitations, the writer has in his possession some 1,700 bulletins and reports containing articles of more or less botanical interest published by station workers during the twenty-five years he has been interested in this work. From a purely scientific point of view most of these could have been omitted, but from an educational one they doubtless all have a reason for their existence. These articles, and an equally large number published by the botanists of the Department of Agriculture, lead me in conclusion to a consideration of the investigations in agricultural botany.

Investigations: (1) *Flowering Plants.*—These may be discussed under the three general headings of Flowering Plants, Bacteria and Fungi. Naturally enough, cultivated crops have attracted most attention, but much of this investigation, though semi-botanical in nature, has been made by the agronomists and horticulturists rather than by botanists. Considerable attention has been paid, especially in the past, to variety testing and to methods and time of seeding or propagating, cultivating and fertilizing, different crops, as affecting their growth in various localities.

Among the botanists who have worked along these agricultural and horticultural lines may be mentioned Bailey, with his numerous studies of a great variety of horticultural and ornamental plants; Earle, with his work with southern varieties of fruits and vegetables; Cook and Hume, with tropical plants; and others with special plants, as Mell with cotton, Carleton with wheat, Toumey with the date palm, Bolley with flax, Ball with sorghum, Stuart with potatoes, Selby with tobacco, R. S. Smith with English walnut. In this connection must be mentioned the plant introduction work carried on by the government under the direction of Fairchild and his assistants. Greenhouse problems have received attention from Bailey, Galloway and Stone.

Another line of work more purely botanical in nature was the floristic surveys made in several of the states, especially where the flora was not well known. Nelson's work on the flora of Wyoming has been perhaps as extensive and continuous as any of these. Others who have published station bulletins on the plants of their states are Earle and Mell of Alabama, Bolley and Waldron of North Dakota, Blank-

enship of Montana, Hillman of Nevada, Wooton of New Mexico and Bogue of Oklahoma.

Those who have made studies or tests of the trees and shrubs, both native and introduced, include Roberts of Kansas, Garman of Kentucky, Beal of Michigan, Green of Minnesota, Bessey of Nebraska, Halsted of New Jersey, Kennedy of Nevada, Wooton of New Mexico, Thornber of Washington, Murrill of New York, Burns and Jones (with his assistants), of Vermont, and Blakeslee of Connecticut.

Of course the government has done much work along these systematic lines, especially with the western flora, beginning with the publications of Vasey and continued by those of Coulter, Coville, Rose, Britton, Piper, and others. This work has now largely returned to its original home in the Smithsonian Institution, leaving only the more practical studies to the Department of Agriculture.

Starting with Vasey's economic work with the grasses, there have been many investigations to determine the most valuable hay, meadow and range grasses, and especially the conditions affecting the last. These have involved detailed studies of classification, distribution, habits of growth, environment, and chemical composition. Somewhat similar studies have been made with legumes and certain forage cacti. Among the investigators concerned with this work may be mentioned F. Lampson-Scribner, Hitchcock, Nelson, Pammel, Williams, Kennedy, Griffiths, Piper, Wooton, and Thornber.

Weeds, especially their identification, nature and methods of eradication, have been another means of keeping botanists busy, more especially in the earlier days. Particularly bad pests, such as the Canada and Russian thistles, tumbleweeds, mustards, couch grass and orange hawkweed, have received especial study. General and special consideration of the weed problem early received attention from Dewey of the department, Millspaugh of West Virginia, Halsted of New Jersey, and Harvey of Maine. Special articles on particular weeds or lists of weeds in their respective states, have been published by botanists too numerous to mention. At first attempts were made to have laws passed regulating weed pests, but there has been little activity along this line in recent years, and such laws as exist are rarely enforced.

Seed testing has also had its share of attention from the station and government botanists. This work has included methods of identification, kinds of impurities and adulteration, and tests for germination. Laws have been enacted in several of the states relating to the sale and testing of seeds. The work, while important, has never received quite the detailed attention here that has been given to it in some of the European countries. Besides the publications of the Department of Agriculture, numerous others have been issued by the stations at Maine, Connecticut, North Carolina, New York, Kentucky, Ohio, Michigan, Iowa, Nebraska, North Dakota, and some other states.

Poisonous plants have claimed especial care from Chestnut, Wilcox and Pammel, with contributions from such others as Blankenship, Bessey and Halsted. Drug plants have been dealt with by True and his associates.

Physiological and chemical studies of plants have not had so much attention from botanists as some other lines of investigation, yet good work has been accomplished by Loew, Swingle, True, Alsberg, Kearney, Briggs, Schantz, and others of the department. Much of this work relates to soil moisture and soil solutions both favorable and detrimental to plant growth. Various

station workers, as Stone, Duggar and Reed, have made investigations dealing with special problems involving physiological and chemical study. Through the cooperation of the botanists with the chemists, the general chemical composition of many plants, especially grasses, has been determined.

Plant breeding is one of the most recent lines of work that has been taken up by several of the stations. This in reality is not so new as it may seem, for various horticulturists and agriculturists, as Sturtevant with corn, Munson with fruits, McClure with sweet corn, and Hayes with wheat, and such botanists as Halsted with vegetables, Webber with citrous fruits, and Carleton with cereals, had long been interested, as shown by their publications. Recent work, however, has aroused new interest, and we may merely mention in passing that of Smith, East, Shull and Hartley with corn, Selby, Shamel, East and Hayes with tobacco, Roberts with wheat, McLendon with cotton, Groth with vegetables, Emerson and Belling with beans, Webber and Clark with timothy, Hansen with fruits, and Love with oats. Some of these investigations have aimed to solve the laws that underlie plant breeding, and others chiefly to produce more valuable strains or increased yields of the plants investigated.

(2) *Bacteria.*—Coming to bacteriological investigations, we find that, on the whole, our botanists have not taken so prominent a part in the work. This is because bacteriology as now constituted, though it deals with plants, is considered a distinct science. So, with the exception of teaching, in part, and investigations of plant diseases, bacteriology has passed mostly outside the realm of botany. In fact, as regards general sanitation and the bacterial diseases of man and animals, our botanists have never done much work. Burrill has always been interested in these lines, and one of his students, Briscoe, published bulletins on the tubercle bacillus. Chester, like Burrill, did a little work with animal diseases, and several botanists have published popular articles.

Dairy bacteriology also has remained largely a subject for specialists outside of the botanical realm, though such biologists as Conn, Russell and Marshal have done good work.

Soil bacteriology, however, has come a little closer home, and has occupied the attention of Chester, Kellerman, and a few others, while Burrill, Schneider, Moore, Kellerman, Duggar, Harding and Garman have been interested in the question of the bacteria of root tubercles on legumes.

Coming to the work with plant diseases, however, we find the botanists of this country have accomplished more in this line than all the rest of the world. To start with, Burrill was the first to prove that bacteria cause disease in plants; and, in the development of this line of work, Smith of the Department of Agriculture has accomplished results that place his name high among American botanists.

Among the many who have published articles dealing with special bacterial diseases of plants may be mentioned those of Burrill, Arthur, Waite, and Whetzel on pear blight, of Thaxter, Bolley and Lutman, on potato scab, of Smith, Townsend, Hedgcock, and C. O. Smith on crown gall, of Pammel and Smith on black rot of cruciferous plants, of C. O. Smith on walnut blight, of Jones on bacillus of carrots, of Stewart on the corn disease, of Stevens on tobacco wilt, of Manns on the oat disease, of Giddings on the rot of melons, and of Johnson on the coconut bud rot.

(3) *Fungi, etc.*—Taking up the last line of investigations, those with the fungi, one finds himself overwhelmed with the amount

of good work that has been done. If the American botanist leads in any kind of investigation, it certainly is in the study and treatment of plant diseases. One of the earliest lines of work was listing the species of fungi that were found in the different states, such lists, often descriptive, being published by Burrill for Illinois, Atkinson and Earle for Alabama, Tracy and Earle for Mississippi, Williams for South Dakota, Jennings for Texas, and Jones and Orton for Vermont.

Many botanists have made similar surveys for the destructive fungi of their economic plants, as Halsted for New Jersey, Pammel for Iowa, Selby for Ohio and Stewart for New York. Sturgis, and Stevens with his students, have been concerned with the literature of plant diseases; and Atkinson, Duggar, Freeman and Stevens have published books dealing with fungi. Farlow, Atkinson, Duggar, and some others have contributed data concerning edible and poisonous mushrooms. Von Schrenk, Hedgcock, Spaulding, Metcalf, Heald, Graves and Long have made studies of the diseases of trees and the decay of timber. Thaxter, Rolfs, Fawcett and Speare have been interested in the fungous diseases of injurious insects.

Determination of the alternate stages of fungi has been an entrancing study for those engaged in it, and special mention should be made of such work with the rusts by Arthur, Kern, Olive and others of Arthur's students. Artificial culture of fungi commenced with the early work of Thaxter and Atkinson, and now plays an important part in all mycological investigations, those of Shear, Heald and Edgerton well illustrating this type of work.

Disease resistance to specific fungi has received attention from Orton, with cotton and watermelons, Carleton and Freeman with cereals, Bolley with wheat and flax, Stuart with potatoes, Norton with asparagus, and Blinn with muskmelons.

In addition to the preceding, many studies have been made of physical injuries and so-called physiological diseases of plants. Prominent among such studies are those of Smith with peach yellows and rosette, Atkinson with edema troubles, and Woods, Allard and Chapman with calico of tobacco. Stone has contributed to our knowledge of injury by electricity; Sturgis, Bain and many others, of spray injury. Winter injury has received especial attention from Waite, Selby, Grossenbacher, Morse and others.

One of the most practical lines of work has been the so-called "squirt-gun botany," which deals with the treatment of plant diseases by spraying. Among the early investigators working along this line should be mentioned Goff with apple scale, Lamson-Scribner with grape rots, Thaxter with quince leaf-blight, Jones with potato blight, Chester with brown rot of peach, Lodeman with fruit diseases, and Galloway, Halsted, Stewart and Selby with a great variety of diseases.

As Bordeaux mixture is one of the oldest and most frequently used of the fungicides, it has received especial attention as to its composition, action, etc., in articles by Chester, Fairchild, Crandall and Lutman. In recent years lime-sulphur, borrowed from the entomologists, and first used as a fungicide in the west by Pierce and others, has been brought into prominence in the east by the work of Scott of the Department of Agriculture, and by various station botanists. The development of the self-boiled lime-sulphur by Scott is a still more recent factor in spraying.

Hot water treatment for smuts of grain first received attention in this country from Kellerman and Swingle, while Bolley and later Arthur brought forth formalin for

a similar purpose; and Thaxter, the use of sulphur for onion smut. To Bolley we are chiefly indebted for the use of corrosive sublimate and formalin solution as remedies for potato scab, while Morse has used the fumes of formalin as a substitute.

Our pathologists seem to have been in their prime, however, when making detailed life history studies of economic fungi. The particular foes of each cultivated plant have received attention, though naturally those that are most common and destructive have had special consideration. If time permitted we should like to mention these more specifically. Each of our numerous mycologists has contributed his part to the work. Some few of these investigators have already passed to the great beyond, and others are gradually laying aside the work; many, however, are yet in their prime, while there are still more just coming into prominence. Of the last I would say that their standard of work is as high, if not higher, and their training better, than that of the older investigators, though the opportunities for original work grow less or more difficult with each year. Perhaps, however, I am mistaken, and it is only the nature of the work that changes, as indicated in letters to the writer from the late M. C. Cooke of England, who, with Ellis and Peck of this country, though not directly connected with agricultural botany, has greatly helped it by systematic work with the fungi. In conclusion permit me to quote these friendly sentiments of Cooke:

> For the past forty years and more I have had kindly correspondence and good feeling with botanists in the states, some of whom I claim as my pupils in mycology. From the time of Asa Gray, one of my first friends, I have had many. Half a century has passed me in the study of fungi, and I find as much still to learn, but I am too old now to do more than float over the surface, and confine myself to plant diseases. I note with great gratification the immense development of this branch of study on your side, which puts us to shame. Your experiment stations are fine institutions. . . . I care not who does the work, only I am delighted to see it is being done, and, between ourselves, to realize that it is being done by an English-speaking race and not by Germans or Frenchmen. To my American brethren, the mycologists, I am wishing God speed, and I care not how they beat us so long as they keep it up on a high level, clear of empiricism and worthy of the race.

G. P. CLINTON
CONNECTICUT AGRICULTURAL EXPERIMENT STATION

THE MINERAL PRODUCTION OF THE UNITED STATES IN 1915

THE midyear review of mining conditions reported to the Secretary of the Interior on July 1 by the Director of the United States Geological Survey is well supported by the preliminary reports for the year. The Geological Survey is making public its usual estimate of mineral production for 1915 in the form of a separate statement for each of the more important mineral products.

A review of these statements confirms Secretary Lane's comment of last July to the effect that the mining revival is in full swing. In the western states alone the metal production shows an increase in value of more than $130,000,000 over the corresponding figures for 1914; and the year's increase in output for the principal metals measured in value is more than $250,000,000. Moreover it is not unreasonable to expect that when the full returns for all mineral products are compiled they will show that 1915 was the country's most productive year in the mining industry. The total may even reach two and one half billion dollars.

In the response to bettered conditions the production figures for copper, iron and zinc show the largest increase.

The copper mines passed all records for previous years, the 1915 output having a value of $236,000,000, or $83,000,000 more than the value of the production for 1914. The statistics and estimates received place the output of blister and Lake copper at 1,365,500,000 pounds or more than 120,000,000 pounds in excess of

the largest previous production and eighteen per cent. above last year's figures. Only twice in the history of copper mining has there been a larger increase in quantity of metal produced.

The total shipments of iron ore from the mines in the United States in 1915 are estimated to have exceeded 55,000,000 gross tons, an increase over 1914 of more than 38 per cent. Based on the same price as received in 1914 this represents an increase in total value of about $27,645,000. The increase in pig iron is estimated at 6,500,000 tons, with a total increase in value of pig iron production of more than $120,000,000.

The output of zinc (spelter) made from domestic ores was larger than ever before, being about 425,000 tons, worth $120,000,000 as compared with 343,418 tons in 1914, an increase of about 82,000 tons or nearly 25 per cent. in quantity and of $85,000,000 in value. Production was increased during the latter half of the year, as the production during the first half was at the rate of 415,000 tons annually and at the rate of 436,000 tons during the last half.

The output of refined pig lead from domestic ores was about 515,000 tons, worth about $48,500,000 as compared with 512,794 tons in 1914, an increase of only 2,500 tons in quantity but of $8,500,000 or 20 per cent. in value. The production of antimonial lead was 20,550 tons as compared with 16,668 tons in 1914, an increase of 3,882 tons or 23 per cent. in quantity and an increase in value of nearly $2,000,000.

The annual preliminary estimates on the production of gold and silver in the United States, made jointly by the United States Geological Survey and the Bureau of the Mint, are not yet complete, but early figures based on reports from the mines indicate an increase in mine production over that of 1914 of over $7,000,000 in gold, principally from Colorado, California, Alaska, Montana and Idaho, and an increase in mine production of silver of fully 4,000,000 ounces, chiefly from Montana, Utah and Arizona. This increase in gold production may bring 1915 up to the record year of 1909, when the gold output of this country was nearly $100,000,000.

Quicksilver also has had its best year in 1915. The quantity increased 25 per cent. over 1914, but the value of the output more than doubled owing to the much higher prices. The estimated production was 20,681 flasks of 75 pounds each, valued, at the average price for the year—the highest in the last forty years—at $1,768,225. In value, this domestic production was the highest since 1881 and in quantity the largest since 1912.

The production of bituminous coal and anthracite in 1915 is estimated to have increased between four and five million short tons, or less than 1 per cent. The quantity of bituminous coal mined increased about 6½ million tons and that of anthracite decreased over two million short tons. Owing mainly to steady demands for export coal and for coke for steel making, the output in Pennsylvania, West Virginia, Kentucky and Alabama increased over last year, but little change is recorded in other eastern states. The region west of Ohio, including the Mississippi Valley, shows a general decrease, Colorado being the only western state to show betterment.

Connected with the coke industry was the completion during the last summer of a number of large plants for the recovery of benzol from by-product coke-oven gas. This gives the United States its first output of this material, so important as a raw material in the manufacture of high explosives and chemical dyes, and the amount of this product will be reported later.

Preliminary estimates of the total output of petroleum in the United States in 1915 indicate a slight increase over the corresponding output in 1914. It is believed that the total petroleum yield of the United States in 1915 amounted to 291,400,000 barrels, of which quantity it is also estimated that 267,400,000 barrels was marketed and 24,000,000 barrels placed in producers' field tankage during the year.

The sulphuric acid industry in 1915 presented interesting development. In spite of the abnormal demand and higher prices in the latter half of the year, much of the sulphuric acid had been contracted for or was con-

sumed in the factories where made. The estimated production indicates an increase of 6½ per cent. in the three common grades, but more than 100 per cent. in the strongest grades.

The estimate of Portland cement output in 1915 indicates shipments from the mills of 86,524,500 barrels, an increase of one tenth of one per cent. over 1914. There was a slight decrease in production and this, with the appreciable decrease in stock, indicates a more conservative trend in the industry, which in the preceding few years showed a tendency to overproduction. Prices generally averaged a few cents lower per barrel in 1915 than in 1914, although toward the end of the year prices were substantially increased, and the outlook for 1916 is brighter than for several seasons.

Perhaps the most notable item in the year's record is the stimulation of metal mining in the western states. Almost without exception the increases in production were large and in several states 1915 was the best year on record. In Arizona, which leads in copper, the output of that metal exceeded the previous record production of 1913. California continues to lead in gold and had the largest yield in thirty-two years, and with one exception in half a century. In Montana and Arizona record outputs of silver are reported and in Alaska the increased production of gold and especially copper made 1915 a much more prosperous year than even 1906 when Fairbanks and Nome were yielding their greatest returns of gold from bonanza placers.

MEDALISTS OF THE ROYAL SOCIETY

AT the anniversary meeting of the Royal Society on November 30, the president, Sir William Crookes, characterized the work of those on whom the medals of the society had been conferred as follows:

The Copley medal has been conferred upon Professor Ivan Petrovitch Pavlov, one of our most distinguished foreign members, whose researches in physiology have led to the acquisition of valuable knowledge. By a most ingeniously worked-out and original method of making fistulæ or openings to the exterior, Professor Pavlov has successfully studied the interrelation of the functions of the alimentary canal. His experiments have shown how the presence of food in one cavity controls the secretion of digestive juices into the next, and he has made many discoveries concerning the conditions which influence the secretory process, while his method has facilitated the study of the chemical changes which occur in the food as it passes through the canal. Moreover, by the method which he calls that of conditioned reflexes, Professor Pavlov has studied, from a physiological point of view, the influence of the higher brain centers upon the secretion of saliva. He has also investigated the mechanism of the muscle by which bivalves open and close their shells, and the nervous control of the heart, especially through the sympathetic nerves. His resourcefulness and skill have enabled him to make important contributions to physiological science, and his work, the true worth of which has, perhaps, not yet been rightly prized, deserves the fullest recognition.

The Royal medal given annually for physical investigations has been awarded to Sir Joseph Larmor, whose work in mathematics and physics includes a very wide range of subjects—geometry, dynamics, optics, electricity, the kinetic theory of gases, the theory of radiation and dynamical astronomy—upon all of which he has published illuminating memoirs. Possibly his chief claim to distinction is the establishment of the theory that radiant energy and intramolecular forces are due to the movements of minute electric charges. This theory is fully worked out in his treatise, "Æther and Matter." For a long time Sir Joseph Larmor acted as secretary to the Royal Society, performing the duties of the office with great success, at the same time continuing with unabated vigor original research. The offer of the Royal medal is a mark of the society's appreciation and admiration of his invaluable services to science.

The other Royal medal, for work in the biological sciences, is this year conferred upon Dr. William Halse Rivers Rivers, whose work in ethnology has contributed largely to the establishment of the subject upon a scientific basis. He was the first to use the genealogical method in ethnological investigations. His remarkable originality, combined with sound judgment, have enabled him to produce work which will rank with the best that has been done in ethnology.

All chemists will agree that the award of the Davy medal to Professor Paul Sabatier is fully justified. His lengthy researches on the use of finely divided metals as catalysts are universally known. The hydrogenation of unsaturated or-

ganic compounds, especially by means of nickel, has been thoroughly elucidated by Professor Sabatier and his coworker, the Abbé Senderens. The industrial application of the process to the unsaturated acids of the oleic series has already acquired considerable industrial importance. It gives me great pleasure to announce the award, so well earned by Professor Sabatier.

The Hughes medal is awarded to Professor Paul Lanvegin, who has made valuable contributions to electrical science, both on the theoretical and experimental sides. He has found by experiment the rate of recombination and the mobility of ions produced by different processes in gases at various pressures, and he has made an exhaustive study of the theoretical aspects of the interdiffusion of gases and the mobility of ions.

MEMORIAL TO JOHN WESLEY POWELL

The Department of the Interior has completed, on the rim of the Grand Canyon, in Arizona, a memorial to Major John Wesley Powell, the pioneer and distinguished man of science who first explored the Grand Canyon. The memorial is an altar decorated in Indian imagery and supporting a bronze tablet, resting upon a pyramidal base of rough-hewn stone. Fifteen steps lead from the west up to the altar floor, from which one may gaze into the very heart of the glowing mile-deep canyon. It is a structure worthy alike of the rugged, forceful personality of the man and of the titanic chasm which it overlooks.

The spot chosen for the memorial is Sentinel Point, a promontory south of the railway station, which commands a particularly fine view of the Granite Gorge and of the river, whose unknown terrors of whirlpool and cataract the Powell party braved in small open boats. The structure, which is built of weathered limestone from the neighborhood, has a rectangular base 21 by 28 feet. The altar carries on its east side a medallion portrait of Major Powell in bronze bas-relief by Leila Usher and the following inscription:

> Erected by the congress of the United States to Maj. John Wesley Powell, first explorer of the Grand Canyon, who descended the river with his party in rowboats, traversing the gorge beneath this point August 17, 1869, and again September 1, 1872.

The general effect is unobtrusive, natural and appropriate. A few small, gnarled trees grow close by, but do not obstruct the view. The structure stands back from the edge sufficiently to permit visitors in considerable numbers to group themselves in front.

The memorial was planned at the International Geological Congress of 1904 in recognition of Major Powell's distinguished services as director of the United States Geological Survey. In March, 1909, Congress appropriated $5,000 for the purpose, "in recognition of his distinguished public service as a soldier, explorer and administrator of government scientific work." Dr. H. W. Holmes chose the site.

The original plan was to make the memorial a Roman chair facing the canyon. Last spring Secretary Lane substituted an altar for the chair, and Mark Daniels, then general superintendent and landscape engineer of National Parks, designed the structure as it stands to-day.

It was then late in July, and Mr. Walter Ward, engineer of the Reclamation Service, had a difficult task before him to find and hew the rock and build the structure within the slender appropriation.

This memorial, so expressive of the spirit and character of the man whose life work it celebrates, and so admirably located, will be formally dedicated early next summer. If, as is expected, Congress meantime makes the Grand Canyon a national park (it is a national monument now), the two dedications will take place together, making a celebration altogether notable in the history of national parks.

SCIENTIFIC NOTES AND NEWS

Dr. Charles R. Van Hise, president of the University of Wisconsin and previously professor of geology, has been elected president of the American Association for the Advancement of Science, in succession to Dr. W. W. Campbell. The other officers elected at the Columbus meeting of the association and an account of the proceedings will be found elsewhere in the present issue of Science.

DR. JOHN M. CLARKE, New York state geologist and director of the State Museum, was elected president of the Geological Society of America at the recent Washington meeting.

DR. RAYMOND DODGE, professor of psychology at Wesleyan University, has been elected president of the American Psychological Association.

OFFICERS were elected at the New Haven meeting of the American Association of Anatomists as follows: *President,* Dr. Henry H. Donaldson, Wistar Institute; *Vice-president,* Professor Clarence M. Jackson, University of Minnesota; *Members of the Executive Committee,* Professor Eliot R. Clark, University of Missouri, and Professor Reuben M. Strong, University of Mississippi. Professor C. R. Stockard, Cornell Medical School, New York City, remains secretary of the Association.

OFFICERS of the Elisha Mitchell Scientific Society, Chapel Hill, N. C., for the year 1916 are as follows: *President,* Dr. J. B. Bullitt; *Vice-president,* Professor T. F. Hickerson; *Permanent Secretary,* Dr. F. P. Venable; *Recording Secretary and Treasurer,* John E. Smith; *Editorial Board of the Journal:* Dr. W. C. Coker, Professor Collier Cobb and Dean M. H. Stacy.

AT the annual dinner of the Geographic Society of Chicago, the gold medal of the society was presented to Major-General William C. Gorgas. The presentation address was made by Dr. Frank Billings. General Gorgas gave an address, entitled "Sanitation in Its Relation to Geography."

WE learn from the *Journal* of the American Medical Association that the Royal College of Physicians of London has awarded the Moxon gold medal to Dr. Dejerine, professor of diseases of the nervous system at the Faculté de médecine de Paris. This medal is awarded every three years to the scientist whose observations and researches in clinical medicine are deemed to render him most worthy of this distinction. The award of the medal is not reserved for scientists of British nationality, but up to the present it has been given only to English clinicians; Sir Alfred Garrod (1891), Sir William Jenner (1894), Sir Samuel Wilkes (1897), William Tennant Gairdner (1900), John Hughlings Jackson (1903), Jonathan Hutchinson (1906), Sir William Richard Garvers (1909), Sir William David Ferrier (1912).

THE *British Medical Journal* states that the Leeuwenhoek gold medal of the Royal Academy of Sciences, Amsterdam, has been awarded to Surgeon-General Sir David Bruce. It is awarded every ten years in recognition of the most important work done during the decade on the microscopical organisms first discovered by Leeuwenhoek in 1675. The award sets out that it was the discovery of the *Micrococcus melitensis,* the cause of Malta or Mediterranean fever, which first made Bruce's name generally known. This was followed by the discovery of the cause of African cattle, or tsetse fly disease, known as Nagana. Afterwards he made extensive researches, with the help of a staff of assistants, into other tropical African diseases caused by trypanosomes, especially into sleeping or Congo sickness caused by the *Trypanosoma gambiense* and transported chiefly by the fly *Glossina palpalis.* The medal was presented at the meeting of the Academy of Sciences in Amsterdam on December 18.

SIR W. H. SOLOMON and Professor G. H. Bryan have been elected to honorary fellowships at Peterhouse, Cambridge.

MR. GEORGE L. FAWCETT, from 1908 until last February the plant pathologist at the Porto Rico Experiment Station at Mayaguez, and since that time occupying a similar position at the Experiment Station in Tucuman, Argentina, has been appointed professor of mycology and bacteriology at the University of Tucuman.

DR. WILLIAM H. WELCH, professor of pathology in the Johns Hopkins Medical School, who has been in China devising plans to introduce modern medical methods in the empire, and Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute, reached San Francisco on December 27.

Dr. Frank Angell, professor of psychology in Stanford University, has sailed for England to take part in Belgian relief work.

Professor Joseph M. Flint, of the Yale Medical School, has returned to New Haven after five months of work among wounded soldiers in the hospital at Chateau de Passy in France.

Dr. John F. Anderson, formerly director of the Hygienic Laboratory, United States Public Health Service, and now director of the research and biological laboratories of E. R. Squibb & Sons, New Brunswick, New Jersey, has sailed for England and France to study the methods in use in the armies of those countries for the prevention and treatment of wound infections.

Professor Jacques Loeb, of the Rockefeller Institution for Medical Research, delivered an address on "Adaptation" at the meeting of the Philadelphia County Medical Society on December 8, which was followed by a reception and supper. The meeting was arranged by the committee of the medical society on cooperation among allied agencies and institutions.

Dr. Alexander C. Abbott, professor of hygiene and bacteriology, the University of Pennsylvania, delivered an illustrated lecture on "The Transmissibility of Diseases and the Public Health" at Franklin Institute on the evening of December 15.

Dr. Henry E. Crampton, of Columbia University and the American Museum, delivered the oration before the Phi Beta Kappa Association of the University of Pennsylvania on December 4. Dr. Crampton took for his subject "Science, Culture and Human Duty."

Professor Edward Kasner, of Columbia University, spoke on "Some Unsolved Mathematical Problems" at the College of the City of New York on December 16.

The Herbert Spencer Lecture at Oxford University for 1916 will be delivered by Professor J. Mark Baldwin. The subject of the lecture is not yet announced.

The Croonian Lecture of the Royal Society was delivered on December 9, by Dr. W. M. Fletcher and Professor F. G. Hopkins, on "The Respiratory Process in Muscle, and the Nature of Muscular Motion."

A bronze portrait plaque has been placed in the Evans Dental Institute, to the memory of W. D. Miller, a graduate of the Dental School of the University of Pennsylvania, class of 1879. The plaque is the gift of the International Dental Federation. At the annual convention held in Berlin in 1909, a resolution was passed to present a bronze memorial plaque to the Dental School of the University of Pennsylvania, dedicated to one of its most distinguished graduates, W. D. Miller, who was a distinguished scientific man and one of the most eminent men in his profession.

Daniel Girard Elliot, distinguished for his contributions to mammalogy and ornithology, died at his home in New York City, on December 24, aged eighty-one years.

David Williams Cheever, emeritus professor of surgery in the Harvard Medical School, died at his home in Boston, on December 27, in the eighty-fifth year of his age.

Dr. James Holms Pollok, for many years on the staff of the Royal College of Science for Ireland, in the chemical department of which he was lecturer on physical and metallurgical chemistry, died on November 26.

Mr. C. J. Wollaston, known for his pioneer work in submarine telegraphy, has died at ninety-five years of age.

The death is announced of Charles René Zeiller, a member of the French Institute, chief engineer of mines and professor of paleobotany in the Paris School of Mines.

Adolphe Greiner, director-general of the foremost steelworks in Belgium, this year president of the Iron and Steel Institute, died at his residence near Liège on November 20, aged seventy-three years.

The United States Civil Service Commission announces an open competitive examination for fish pathologist in the Bureau of Fisheries on January 19, 1916. The duties of the fish pathologist are primarily to investigate the causes, the nature and the effects of

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disease of fish or shellfish, physiological or environmental conditions associated with the development of pathological phenomena, and the means of prevention or cure. The investigation of stream pollution is involved, as well as the study of the physical, chemical and biological conditions that may be salutary or deleterious to fish. Competitors will be examined in general biology, physiologic chemistry and parasitology, with particular reference to aquatic animals. Credit will be given for thesis and manuscript or published reports. Graduation with a bachelor's degree from a course in a college or university of recognized standing and, in addition at least two years of postgraduate work, or the equivalent, in chemistry or biology are prerequisites for consideration for this position. The salary is $2,500 per annum.

THE Weather Bureau asks for an appropriation of $30,000 for extending the Carribean weather observations with a view to a system of communication of "considerable value in connection with the military and naval operations in the canal zone." Instead of observations once a day during a seven months' period at an inadequate number of stations, a continuous all-year-round service would be established at additional stations in South and Central America and along the southern gulf coast. A $25,000 structure on the canal zone to serve as the official headquarters for the weather service in that section also is planned.

THE equipment of the department of entomology at the University of Illinois, and of the natural history survey of that state, receives a notable addition in the new vivarium building in Champaign, which will contain a large insectary for student use, with three laboratory rooms in connection, an apparatus, furnished conjointly by the university and the State Laboratory of Natural History, for temperature and humidity control in the study of insect life histories, and a set of experimental aquaria fitted up for exact studies on the ecology of fresh-water animals. The insectary and entomological laboratories will be under the charge of Dr. R. D. Glasgow, and the state laboratory equipment under that of Dr. V. E. Shelford, of the laboratory staff.

THE *Journal* of the American Medical Association says: "On last Monday, December 20, the Supreme Court of Illinois rendered a ruling—it was not a decision, as the newspapers stated, but simply a ruling—in the case of Lydston *vs.* the State's Attorney. The newspapers, in sweeping statements—inspired?—have carried the impression that the ruling is against the American Medical Association; that the officers, including trustees, are holding their offices illegally; that a new election must be held immediately, etc. Nothing could be farther from the truth. It is the old story; it is merely another step in the case started about the time of the meeting of the American Medical Association in St. Louis in 1910, at which time Lydston tried to compel the state's attorney to bring *quo warranto* proceedings against the association. The American Medical Association has not yet technically been brought into the case; thus far the issue has been between Lydston and the state's attorney. The technical announcement of the ruling just made is "Hoyne, State's Attorney *vs.* People ex rel; Lydston; petition certiorari denied." The state's attorney tried to get a decision from the Supreme Court, but the Supreme Court declined to hear the case at this time and therefore denied the writ of certiorari.

ACCORDING to a press dispatch proposed legislation to create a government bureau of volcano observation is under consideration. The project, as outlined to congressional leaders by T. A. Jagger, of the Massachusetts Institute of Technology, a delegate to the Pan-American Scientific Congress, contemplates the securing of information on which ultimately predictions of volcanic disturbances may be based as well as studies of gases and liquids in the earth which may prove of value in connection with weather observations. There are said to be between four hundred and five hundred living volcanoes in the world, about one fourth of which are within United States territory, in Alaska, Hawaii and the Philippines.

The fifth annual meeting of the Oklahoma Academy of Science was held at Oklahoma City, Oklahoma, November 26 and 27, 1915. Thirty-five papers, dealing with various phases of biology, physics, chemistry and geology were presented. The address by the retiring president, Mr. Chas. W. Shannon, director of the Oklahoma Geological Survey, dealt with the work of the Oklahoma Academy of Science and its connection with the scientific work of the state. The following officers were elected for the ensuing year:

President, Chas. N. Gould, Oklahoma City.
First Vice-president, L. Chas. Raiford, Stillwater.
Second Vice-president, L. B. Nice, Norman.
Secretary, G. K. Stanton, Enid.
Assistant Secretary, Ethel L. McCafferty, Enid.
Treasurer, H. H. Lane, Norman.
Curator, Fritz Aurin, Norman.

The next meeting of the academy will be held in November, 1916, at the time and place of the meeting of the Oklahoma State Teachers' Association.

The Stanford University Medical School announces the thirty-fourth course of Popular Medical Lectures to be given in Lane Hall on alternate Friday evenings as follows:

January 14. "Medical Research and Its Relation to General Medicine," by Dr. George H. Whipple, director of the Hooper Foundation for Medical Research.

January 28. "The Economic Aspect of Disease," by Murray S. Wildman, Ph.D., professor of economics.

February 11. "Disease Carriers," by Dr. W A. Sawyer, secretary, California State Board of Health.

February 25. "The Relation of Hospitals to the Community," by Dr. George B. Somers.

March 10. "Locomotion in Health and Disease," by Dr. Walter F. Schaller.

March 24. "Mental Hygiene," by Lilien J. Martin, Ph.D., professor of psychology.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Miss Rose Hollingsworth, of Boston, the Massachusetts Institute of Technology, Radcliffe College, Mount Holyoke College and the Tuskegee Industrial Institute each receive $5,000. Five hundred dollars are bequeathed to the Gray Herbarium, the National Association of Audubon Societies, the Society for the Protection of Native Plants, the American Forestry Association and to the Massachusetts Forestry Association.

A gift of $75,000 has been announced to the Harvard Medical School. This is the balance of the bequest of Morrill Wyman, who established the Morrill Wyman Medical Research Fund, the income of which is to be applied in promoting investigation concerning the origin, results, prevention and treatment of disease.

The executors of the estate of the late Lord Strathcona have notified Queen's University, Kingston, that the $100,000 left to that university is now available and ready to be paid.

A valuable collection of periodicals, monographs and other medical books, consisting of more than 4,000 volumes, has been presented to the Johns Hopkins Hospital by Dr. Howard A. Kelly.

Professor Henry A. Perkins, of the department of physics, is acting president of Trinity College during the absence of President Luther.

DISCUSSION AND CORRESPONDENCE

THE ORIGIN OF THE "NITER SPOTS" IN CERTAIN WESTERN SOILS[1]

In a recent issue of Science, under the above title, Sackett and Isham[1] discussed this important question but conveyed no actual information regarding either the meaning of the term "niter spot" or its origin. They merely select for discussion a single point out of the great mass of available material so that the general scientific reader to whom an appeal is thus made through the columns of Science is left in doubt as to what it is all about. In order to clarify the matter for the average reader, it seems advisable to submit some definite information on the subject in

[1] Sackett and Isham, Science, Vol. XLII., p. 452, October 1, 1915.

order that those who are not familiar with the data in the technical publications may form an intelligent opinion regarding the merits of the several theories proposed regarding the origin of these spots.

The term "niter spots" has recently been applied by Headden[2] to alkali accumulations in certain western soils which develop spots of a dark brown color. Formerly alkali soils were classified as white and black alkali, depending upon the presence or absence of color. The black color of the black alkali spots is due, as shown by Hilgard, to the presence of sodium carbonate, which has a solvent and decomposing action upon the organic matter in the soil. The white alkali consisting largely of the sulphate and chloride of sodium, having no solvent and decomposing action on the organic matter, does not produce any color. There is also an intermediate condition where the color of the alkali spot is a dark or light brown. In these so-called "niter spots" there are two main points which differentiate them from either the white or black alkali soils: (1) the accumulation of large quantities of nitrates; (2) the presence of a brown instead of a black color. The soil of these spots always contains large quantities of the sulphates and chlorides of sodium, potassium, magnesium and calcium. A discussion has arisen regarding the source of the nitrates and color of these special alkali spots.

Three theories have been presented regarding the origin of the nitrates in these spots. (1) Hilgard,[3] who first observed the accumulations of nitrates in certain alkali spots in arid soils, attributed them to the more rapid nitrification of the organic matter in the warm arid soils when the moisture factor was removed by the application of irrigation water. (2) Headden[4] believes them to be due to the fixation of atmospheric nitrogen by the non-symbiotic bacteria, notwithstanding the fact that these bacteria have no power to produce nitrates. Sackett,[5] apparently, adopts both the above views. He evidently assumes that the nitrogen is fixed by azotobacter or other non-symbiotic organisms and later nitrified by the nitrifying organisms. (3) Stewart and Greaves,[6] and later Stewart and Peterson,[7] believe the nitrates are due to the leaching and concentrating action of the irrigating water upon the nitrates occurring in the shales and sandstones (or country rock) adjacent to and underneath the affected areas from which the soil has been derived.

It is imperative to obtain a clear conception regarding the origin of these accumulations for two important reasons: (1) Considerable valuable land is being rendered non-productive, due to these enormous accumulations, and methods of reclamation must await proper conception regarding their origin. If the nitrate accumulations are the result of the concentration of the salts preexisting in the country rock proper methods of drainage, adapted to the peculiar soil formation will be effective in reclamation of the soil of the affected area. On the other hand, if the accumulations are due to the abnormal activity of the non-symbiotic bacteria, drainage is not only not effective in the reclamation of these lands but actually detrimental, since it makes more favorable the conditions for such bacterial activity. If the later conception is true, investigations must be undertaken to devise methods for checking the abnormal activity of the non-symbiotic bacteria. (2) Dr. Hopkins says:

> To increase or maintain the nitrogen and organic matter of the soil is the most important practical problem of American agriculture.

If conditions in certain irrigated soils of the arid west are such as to bring about such an abnormal fixation of atmospheric nitrogen as to render the soil non-productive, due to the production of enormous amounts of nitrates, it is important that the conditions governing such fixation may be clearly understood in order that advantage may be taken of this

[2] Headden, Colorado Exp. Sta. Bul. 155.

[3] Hilgard, "Soils," p. 448.

[4] Headden, Colorado Exp. Sta. Bul. 155.

[5] Sackett, Colorado Exp. Station Bul. 179.

[6] Stewart and Greaves, Utah Exp. Sta. Bul. 114, 1911.

[7] Stewart and Peterson, Utah Exp. Sta. Bul. 134, 1914; *Jr. Am. Soc. Agron.*, Vol. 6, 241.

process in other soils and thus solve the most important problem in American agriculture.

These niter spots are characterized by the following conditions: (1) The presence of large quantities of nitrates; (2) the inevitable presence (usually larger quantities) of other soluble salts such as the chlorides and sulphates of sodium, potassium, calcium and magnesium; (3) the absence of appreciable quantities of soluble carbonates; (4) the presence of a dark brown color or stain; (5) the formation of a hard crust on the surface of the soil; (6) underneath the crust there is a layer of dry dust with fine alkali salt crystals which gives an ash-like or mealy condition of the soil; (7) beneath the ash the soil is moist, sticky and glistening. These niter spots usually occur in cultivated soil after it has been irrigated for a few years. But they likewise occur in the non-irrigated and non-arable soils of the mountains wherever moisture conditions are favorable to the concentration of the salts.

Over four hundred samples of the country rock were collected from the original rock adjacent to the soils in the affected areas and these were analyzed for nitrates and other soluble salts. These data form a basis for the theory developed by us. The soils most affected are those derived from the Mancos shales of the cretaceous as well as from the shales and sandstones of the tertiary deposits.

Sufficient evidence has been presented by us to show conclusively that these nitrate accumulations are the direct result of the concentrating and leaching action of the irrigating water upon the nitrates already existing in the original country rock adjacent to and underneath the affected soils. Briefly summarized, our case rests upon the following evidence: (1) Highly productive, irrigated soils rich in organic matter, free from alkali, are also free from niter spots, or nitrate accumulations. (2) Alkali and nitrate-free soils, under similar climatic conditions, irrigated with water from the same river, geographically adjacent, but derived from different geological series, have been cultivated and irrigated for ten times as long as the niter soils, yet are free from nitrate accumulations. (3) The total alkali salts of any given spot fluctuate from year to year; the nitric nitrogen and total salts, as measured by the chlorine content, increase and decrease in quantity in the same general ratio. The same influences must be at work on both. (4) The amount of chlorides and sulphates present are enormous in quantity and are sufficient in themselves to render the soil non-productive. Thus in a characteristic spot a noted increase of nitric nitrogen in four years of 621 pounds was accompanied by an increase of 128 tons of chlorine and 315 tons of total alkali salts. (5) There is no record of "niter spots" free from these other salts; the nitrates and other alkali salts must therefore be associated in some manner. (6) Lipman[8] has shown conclusively that alkali salts not only do not have a stimulating effect on the production of nitrates in alkali soils, but, on the contrary, nitrification is inhibited. (7) The fixation of atmospheric nitrogen in the non-irrigated soils[9] of Utah is much greater than in the niter soils, yet the nitric nitrogen content of the latter is only normal, being less than six parts per million. (8) Niter spots, possessing all the characteristics, occur in the virgin state in the uncultivated and non-arable areas of the near-by hills wherever the water conditions are such as to cause a leaching and concentrating action on the soluble salts, including the nitrates preexisting in the rock itself. (9) There are large quantities of nitrates in a widely disseminated form, occurring in the country rock adjacent to and underneath the affected soils. (10) These nitrate accumulations although not of any commercial economic importance, so far as known, because of their wide distribution, are more than sufficient, being greater in quantity than those of Chili, to account in full for the nitrate accumulations observed in the alkali soils.

This evidence leads us to the inevitable conclusion that the non-symbiotic bacteria are not

[8] Lipman, *Central f. Bkt.*, Abt. II., Bd. 33, s. 305.

[9] Greaves, *Central f. Bkt.*, Abt. II., Bd. 41, p. 444.

responsible for the production of the nitrates noted in the niter spots of the affected soils of the arid west and their presence there is only incidental and of *no more economic importance than their more abundant occurrence in other normal "niter"-free soils of the arid regions.* The nitrates present in the "niter spots" are the direct result of the leaching and concentrating action of the ground water upon the nitrates preexisting in the country rock adjacent to or underneath the soil of the affected area.

The nature and source of the color present in these spots is of no economic importance whatever except as evidence in support of one or the other of the theories regarding the origin of the nitrates themselves. The azotobacter are in no way concerned in the production of this color. In the normal dry farm soils of Utah the maximum fixation of nitrogen by the non-symbiotic organisms is greater than in the niter soils, yet these soils are free from nitrate accumulation and the color and other characteristics likewise are absent.

The color is due to the solvent and decomposing action of the nitrates upon the old organic matter or humus in the soil. The source of the old organic matter, like the nitrates, may be found in the adjacent shales which as already pointed out are coal- and oil-bearing. Some of the most important coal deposits of Utah and Colorado are found in these shales and sandstones. As a result the ordinary shale contains more or less organic matter. As an illustration, the analysis of twelve samples of shales from near Grand Junction, Colorado, gave an organic nitrogen content of 1,840 pounds per two million pounds of shale.

The assumption of the hydrolyzing action of sodium nitrate and the subsequent humification of the organic matter of the soil to form the brownish colored organic compounds *is as unnecessary as it is untenable.* The solvent and decomposing action (double decomposition) of the nitrates of sodium and potassium upon the old organic matter or humus already occurring in the shale and sandstone is sufficient to account for the production of the color in these "niter spots."

The nitrates of sodium and potassium do have a solvent action on organic matter as already demonstrated.[10] A rich greenhouse soil already abundantly supplied with nitrate was extracted with water for 24 hours as in the official humus determination. A highly colored solution resulted. An aliquot portion on evaporation to dryness and ignition gave a loss of 0.57 per cent. The soil was then extracted with the various soluble salts of sodium, potassium, magnesium and calcium. The variation in intensity of the color was very pronounced with the extract of the different salts. How can this fact be best conveyed to the reader is an important question which arose? The following data were obtained on evaporation and subsequent ignition of an aliquot portion of the extract:

Bases	Sodium				Potassium				Magnesium			Calcium	
Salts	CO_3	SO_4	Cl	NO_3	CO_3	SO_4	Cl	NO_3	SO_4	Cl	NO_3	Cl	NO_3
Per cent. dissolved	5.7	1.19	0.72	0.8	4.2	0.78	0.57	1.4	0.57	0.48	0.49	0.19	0.20

Notwithstanding the confessedly crude method of conveying a conception of the variation in color extracted by the several salts, considering the results as a whole two important facts are evident: (1) the solvent action upon the organic matter of the salts of sodium and potassium and (2) the repressive action of the salts of magnesium and calcium. The solvent action is very pronounced in the cases of sodium and potassium carbonate and the repressive action is very pronounced in the case of the salts of calcium. How may we interpret these data?

The aqueous extract alone dissolved some colored organic matter due undoubtedly to the fact that the soil itself contained *several hundred parts per million of nitrate.* Likewise,

[10] Stewart and Peterson, *Jr. Am. Soc. Agron.*, Vol. 6, p. 247, 1914.

owing to the presence of this nitrate in the soil, the chlorides, sulphates of sodium and potassium exert a solvent action on the organic matter. The potassium nitrate has a decomposition, while the solvent action of the more pronounced solvent action on the organic matter, which is intensified by double carbonates of sodium and potassium are undoubtedly intensified by the hydrolyzation and consequent production of caustic alkali. The salts of calcium exert a repressive action because of the double decomposition and the union of the calcium to formed insoluble calcium salts of the colored organic acids present as already explained. In the presence of old organic material such as occurs in the coal-bearing shale the humifying action of *either the carbonates or other salts* is entirely negligible but it undoubtedly is true that the humifying action upon fresh organic matter of the caustic soda produced by the hydrolyzation of the sodium carbonate is an important factor in the production of the black color of the black alkali spots of alkali soils.

Furthermore, the solvent action of potassium nitrate on old organic matter may be observed in the extraction of peaty soils in the determination of acidity of the soil by the Hopkins method. The potassium nitrate extract of peaty soils in this determination is always colored, due to dissolved organic material. The intensity of the color frequently is so great as to give considerable trouble in the subsequent titration of the extract with an alkali, because the change in color of the indicator can not be observed. The solubility of the old organic matter of peaty soils in potassium nitrate is certainly entirely analogous to the solubility of the old organic matter in the coal-bearing shales and sandstones which constitute the parent material out of which the soils of the "niter" areas are formed.

The color thus can be readily accounted for without the instrumentality of the bacteria, while, moreover, artificial niter spots may be produced in the laboratory on a small scale under conditions which preclude the presence of any bacterial life whatever. Three hundred grams of a greenhouse soil, rich in humus, was placed in small evaporating dishes and the dish filled with a 10-per-cent. solution of sodium nitrate. The solution was then allowed to slowly evaporate by the sun's rays. When all the moisture had evaporated there was produced characteristic niter spots including the color, hard crust and the mealy crystalline condition underneath the crust due to the accumulation of the soluble salts. *These spots were likewise produced when the nitrate was added in the solid form and the moisture added with a saturated solution of mercuric chloride or a 5 per cent. solution of carbolic acid. Control samples of the same soil, in the absence of the nitrate, with or without the antiseptic, failed to produce either the color or other indications of the niter spots.* It is evident, therefore, that the bacteria play no important rôle in either the production of the nitrates or color of the "niter spots" of certain western soils.

In addition to the evidence already published, a detailed paper dealing with the problem as it affects other soils than those already discussed is being prepared and will be published later elsewhere.

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MOTTLED LIMESTONES AND THEIR BEARING ON THE ORIGIN OF DOLOMITE[1]

Several examples of limestone mottled with dolomite have been described during the past few years, but R. C. Wallace was the first to attempt seriously to interpret their meaning. In a very suggestive paper entitled "Pseudobrecciation in Ordovician Limestones in Manitoba"[2] he points out that the dolomite patches in these limestones follow fucoid-like markings suggesting algæ, and concludes that the relationship has resulted from a process of local replacement produced by the magnesia contained in algæ which were imbedded in the

[1] With the permission of the director of the Iowa Geological Survey.

[2] *Jour. Geol.*, Vol. XXI., 1913, pp. 402–421.

limestone at the time it was deposited. He therefore regards the magnesia as indigenous.

It has appeared to the writer that the agents which produced the mottling might be closely bound up with dolomite formation on an extensive scale, and he has accordingly given the phenomenon careful attention in connection with his studies on the origin of dolomite. In the occurrences of mottled limestones observed by him the dolomite patches follow fucoid markings similar to those described by Wallace in some instances, but in others they are very irregular and show no guiding influence. For the origin of both types it seems necessary to adopt an alternative hypothesis; namely, that the magnesia was subsequently introduced into the limestone from without, and that the mottling has resulted from the selective replacement of fucoid markings in the one case, and from the spreading out of the alteration from certain favorable centers in the other. Consistent with this view are the following facts:

1. The existence of unaltered fucoid markings containing less than two per cent. of magnesium carbonate in association with dolomitic ones.

2. The association of both types of mottling with dolomite seams and other evidences of imperfect dolomitization.

3. The graduation of mottled beds into beds which are uniformly dolomitic, both laterally and vertically.

4. The existence of every gradation between limestone showing incipient mottling and true dolomite.

Thus it appears to the writer that all examples of mottling examined by him represent an incipient stage in the process of dolomitization, and it is believed that many dolomites have passed through such a stage in the progress of their formation. Here, then, we have a clue to the origin of all those masses of dolomite with which such mottling is associated.

With regard to the time of the alteration which produced the mottling, there is convincing evidence that it took place in the majority of cases prior to or contemporaneously with the recrystallization of the limestone. Several features lend support to this conclusion; namely, the development of perfect rhombs of dolomite showing no growth interference effects in the limestone about the borders of the dolomite patches; the occasional presence of zonal growths of dolomite and calcite; the tendency of the dolomite areas to spread out uniformly in all directions as the dolomitization proceeded rather than to develop veinlets; and the association of the mottling with imperfect dolomitization effects along original lines of weakness such as bedding planes rather than along secondary structures such as joints or fractures. It seems probable, therefore, that the mottling was produced while the limestones were still beneath the sea, and that the sea water contributed the magnesia.

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SERPENT INSTINCT IN MAN

TO THE EDITOR OF SCIENCE: In the very entertaining and instructive work by Col. Wm. C. Gorgas, "Sanitation in Panama," the author in the concluding pages of the book gives expression to certain philosophizing ideas relating to the earliest period of the existence of the human race, and makes the point that before the discovery by primitive man of fire and clothing his habitat must have been confined to that part of the earth that lies "between the tropics of Cancer and Capricorn," or within narrow limits outside of that region.

There has been much speculation concerning the focus from which the world's population became diffused over the earth's surface, and, at least as far as regards the white peoples of Europe and Asia, the consensus of scientific opinion has fixed upon some locality in central Asia as the probable focus of origin, though the exact or approximate locality seems not to have been defined.

In the writer's reflections along this line there has presented itself to his contemplation one very pronounced and mysterious mental attribute still pertinaciously clinging to the white race at least, which seems to carry evi-

dence corroborative of the above conclusion, pointing, however, more specifically to India as the location of man's early development.

Reference is made to the general prevalence of a deep-seated abhorrence of the serpent and all serpent forms among the white race. This abhorrence of serpents is really a deep-seated animal instinct, which has survived long after the conditions that gave it origin.

Rational persons who are informed on the subject know that the great majority of the snakes to be encountered in this country are entirely harmless, being without venom or fangs; and indeed the writer has determined, to his own satisfaction at least, that in this particular region the only one of the snake family that is a menace to human life is the now rarely encountered *Crotalus horridus*, using the term in a generic sense.

And yet, any intelligent person when unexpectedly brought into close proximity to any kind of a snake, large or small, venomous or non-venomous, or even a semblance of a snake, is suddenly seized by a panic of horror and fear, with an impulse to spring away out of the serpent's reach as quickly as possible in a sort of blind terror.

The probable origin of this instinctive horror of serpents that still dominates the mind of civilized man was during the countless generations when early man was slowly climbing up from his animal ancestry to his present eminence as *Homo sapiens*. Being without fire and without clothing or shelter, he was peculiarly defenseless in an environment beset by deadly serpents, against this, probably the greatest danger and greatest menace to racial survival that he had to encounter. Hence his instinctive horror of the serpent form.

The idea that India was the "cradle" of the white race at least, with its serpent environment threatening racial existence for a very long period of its primitive development, appears to receive some degree of confirmation from the fact that among the inhabitants of India at the present time the annual mortality from attacks of serpents exceeds twenty thousand, notwithstanding the efforts of the British authorities to suppress the evil.

The serpent instinct in man has a close analogy in a similar instinct that characterizes the domestic horse of the present time, to which allusion has been made by writers on the subject. It is a familiar fact to every one who has to do with horses, the proneness of the horse to exhibit an insane and uncontrollable fear of any unfamiliar wayside object. Indeed the phenomenon is such a commonplace that probably very few persons have given a thought in explanation of what appears to be a wholly unaccountable mystery.

The suggestion that has been offered with compelling force to account for this curious horse instinct is on parallel lines with that offered above to account for man's serpent instinct, both of which in the nature of animal instincts are intense and deep seated, and have long survived the conditions that gave rise to them.

In the case of the horse, for a very long period of his racial development he was subjected to one danger exceeding all others in magnitude by which racial survival was constantly threatened. This danger was embodied in the predacious beasts that infested the horse's early environment, mainly of the feline family, that lay in wait concealed by bushes or other cover for the opportunity to spring upon him and devour him. The horse had no means of defense against this danger except alertness in eluding the spring of his enemy and fleetness of foot to escape pursuit. The individual horses that developed these qualities most highly survived, while those that failed to reach an efficient standard fell victims to their enemies.

And we now see, thousands of years after the domestication of the horse, that he suddenly falls into a senseless panic and flees at breakneck speed from an imaginary danger behind him, heedless of real dangers ahead which not infrequently cause him a broken neck.

The instinctive fear of imaginary dangers in the horse, and the same kind of fear of serpents in man, appear to have had a similar genesis in the early experiences of both races.

T. G. Dabney

THE TEACHING OF ELEMENTARY DYNAMICS

TO THE EDITOR OF SCIENCE: Will you please note that the following typographical errors should be corrected in my article in SCIENCE of December 24, page 901:

First column, after (4) "Impulse = Momentum" should be raised two lines, and "From (3)" should be brought down to the line containing $T = 2S/V$.

After (5) "Work done = Kinetic energy" should likewise be raised and "In (4) let" lowered.

Sixth line from bottom, for $A = M/F$ read $A = F/M$.

Second column, third line, for $Wg/32.1740$ read $Wg_1/32.1740$.

WM. KENT

MONTCLAIR, N. J.

SCIENTIFIC BOOKS

Medical and Veterinary Entomology: A Textbook for use in Schools and Colleges, as well as a Handbook for the use of Physicians, Veterinarians and Public Health Officials. By WILLIAM B. HERMS, Associate Professor of Parasitology in the University of California. The Macmillan Company, 1915. Price $4.00.

This is a time in the history of the world when "long-felt wants" are rapidly being filled. A year ago an up-to-date handbook of medical entomology did not exist in printed form, and now we have two excellent works on this subject. The first to appear, "A Handbook of Medical Entomology," by Dr. W. A. Riley and Dr. O. A. Johannsen, of Cornell University, was reviewed in SCIENCE, October 15, 1915. The second, which has just appeared, is a large, well-illustrated and competent book of about four hundred pages, and has been written by a man who has been investigating and teaching the general subject for six years or more at Berkeley. Much of the matter contained in the book was prepared for the press some six years ago, but owing to the very many advances which are constantly being made in the field covered by the book it was withheld until this time, much revised and added to, and now appears at a moment when it is very welcome. Although the author states that his book is not intended to be a comprehensive treatise, but is rather an attempt to systematize the subject and to assist in securing for it a place among the applied biological sciences, it has greatly the appearance of comprehensiveness. The whole field is included in the treatment, and of course for the purposes of the volume the ticks and mites are among the subjects treated. There is also a chapter on venomous insects and Arachnids.

A thoroughly good compilation arranged in a natural and systematic manner would have been a most useful book for the teacher and student as well as the practitioner, but in addition to being such a compilation this book includes a large amount of new material based upon the researches of Professor Herms and his assistants. For example, he details specific experiments in the transmission of bacteria by cockroaches and gives counts of the bacteria of the different parts of the body of the croton bug. His chapters on organization and cost of mosquito control work and on organization and control work against the house fly are especially strong from the very fact that they are based upon extended experience and upon very many experiments. Professor Herms himself has been the adviser in nearly all of the organization and control work of this kind which has been carried out on the Pacific coast, and what he says in this direction is in the highest degree authoritative. His chapter on the stable fly (*Stomoxys calcitrans*) is also strong, and his conclusion to the effect that it is doubtful that this species is the usual agent in spreading polyomyelitis in nature is based upon a careful series of experimental laboratory work with this species and monkeys. The treatment of the important group of fleas and ticks is noticeably full, and his consideration of bee stings, and especially of the morphology and operation of the sting, is very welcome.

In his generalizations concerning mosquito life history, on page 91 and the following, he does not sufficiently point out, it seems to the writer, the enormous differences that exist in the life histories of different species, which

are in fact so great that it is difficult to generalize except in the broadest way. There are very few slips in the book, but it is misleading to read on page 113 that Surgeon-General Sternberg established in 1899 a commission "to study the yellow-fever mosquito theory in Cuba." As a matter of fact the commission was established "for the purpose of pursuing scientific investigations with reference to the infectious diseases prevalent on the Island of Cuba," and it was, as is shown in Agramonte's important article in the last number of *The Scientific Monthly*, the commission's idea experimentally to test Finlay's theory. In this error Professor Herms probably followed the writer's early book "Mosquitoes" (New York, 1901), but it has been several times corrected.

There is much to be said in favor of the rapidly growing substitution of half-tones from good clear photographs for photo-engravings of line and stipple drawings, but it is possible to carry this to an extreme. For example, the illustration of the two-spotted corsair (*Rasahus biguttatus*), page 78, can by no means be considered as a competent illustration of this species, unless it were stated to be a specimen crushed by a violent slap when engaged in sucking the blood of the author! This, however, is an exception, and the great majority of the figures are very good.

Very many students in the universities and colleges and in the medical colleges as well are turning their attention to medical entomology, and perhaps the most rapid advances in the whole field of economic entomology in the immediate future will be in this direction. The timeliness and usefulness of Professor Herm's book under these circumstances can not be doubted, and both he and his department at Berkeley are to be congratulated.

L. O. Howard

Senescence and Rejuvenescence. By C. M. Child. Chicago, The University of Chicago Press. Pp. xi + 481. 201 figures.

A number of biologists have attempted to solve the problem of rejuvenescence by denying its existence. Living substance, they say, grows old, but can never grow young. In each individual some part remains young and it is this that supplies the substance for the process of senescence. Professor Child is not of this belief. To him "growing young" is as real a phase of development as "growing old." This is natural to one who has seen and described the formation of sex-cells from tissue cells and to whom structure is merely a product of function. For some time he has been making a study of rate of metabolism as a criterion of senescence and rejuvenescence and the present volume is largely an exposition of the results of these experiments with a discussion of their significance for the problem of development.

A considerable mass of evidence, according to the author, proves that susceptibility to the cyanides, ethyl alcohol, ethyl ether and similar substances is directly proportional to the rate of metabolism when the strength of the solution is sufficient to kill within a few hours. On the other hand, if the solution is so weak that there is an acclimation effect the animals with the higher rate live longer than those with the lower rate. Starving animals form an exception to the latter rule.

These methods show that increase in age is in general accompanied by decrease in rate of metabolism, but that there are one or more periods in each life cycle that are accompanied by an increase in rate. According to Child these are the periods of rejuvenescence and are found not only in the early cleavage stages following the union of the egg and spermatozoon, but also in the early period of regeneration, in starving animals and under other conditions. He concludes from these considerations that rejuvenescence is a fundamental phenomenon in development and is by no means confined to sexual reproduction. As a matter of fact the changes in metabolism due to amount and character of food and to other environmental factors are according to him in no essential respect different from the others. This attempt to prove fundamental similarity between minor metabolic changes and the major proccesses of the life cycle may be criticized, but Child considers it to be one of the principal virtues of his discussion. When put in physio-

logical terms senescence does not follow an unbroken course.

Non-energistic formulæ do not appeal to the author. In fact he seems to delight in showing his antagonism toward them. For instance, he says that "attempts to connect particular facts with particular chromosomes or parts of chromosomes are not at the present, properly speaking, scientific hypotheses." This and similar statements leave no doubt as to the direction of Professor Child's interest. They may, unfortunately, keep some readers from a fair consideration of the very valuable results of his work.

The extent of the ground covered in the book is well indicated by the titles of the five parts. I. The Problem of Organic Constitution. II. An Experimental Study of Physiological Senescence and Rejuvenescence in the Lower Animals. III. Individualism and Reproduction in Relation to the Age Cycle. IV. Gametic Reproduction in Relation to the Age Cycle. V. Theoretical and Critical. About half of the space is devoted to the experiments of the author and the greater part of the observations appear here for the first time.

The importance of the facts and their general interest make it a matter for congratulation that they have appeared in this connected form rather than in separate papers. The book will be welcomed by all those interested in the problem of development.

CHARLES ZELENY

Land Magnetic Observations, 1911–1913 and Reports on Special Researches. By L. A. BAUER AND J. A. FLEMING. Washington, D. C., 1915. Publication No. 175, Vol. 2, of the Carnegie Institution of Washington. 4to. Pp. v + 278. 13 plates, 9 text-figures.

This is the second volume of the "Researches of the Department of Terrestrial Magnetism," the first volume having dealt with the magnetic observations on land from 1905 to 1910. Some idea of the magnitude of the work carried out under Dr. Bauer's energetic leadership can be gained from the statement that during the eight years following the founding of the department the various expeditions by land and sea covered in all nearly a million miles. Observations were made in 103 different countries and island groups. The results of these expeditions and of special investigations have been embodied in about 125 articles and publications. It is now expected that one of the chief objects for which the Department of Terrestrial Magnetism was founded, the general magnetic survey of the globe between latitudes 70° N. and 65° S., will be completed in 1916. Up to the present time this remarkable achievement has been accomplished without loss of life.

In view of the ever-changing values of the magnetic elements and of our imperfect knowledge of the secular variation in many parts of the earth, it is of immense importance in the analysis of the earth's magnetic field, and thereby ultimately to the navigator and surveyor, that magnetic data be secured for the whole globe at as nearly the same epoch as possible. As has often been remarked, we can never hope to know much about the magnetic field in a vertical direction above or below the earth's surface. Hence a minute and accurate knowledge of the magnetic field over the surface to which we are confined is of all the more importance. It will be greatly to the credit of the Carnegie Institution to have accomplished the task in less than a decade. No cooperation of civilized governments could be expected to do this. It is precisely in work of this sort that a richly endowed private institution can render its greatest service.

The first part of the volume is devoted to a description of instruments, with their corrections, and the magnetic standards finally adopted. Two new universal types of magnetometer have been developed by the department, and seven complete instruments have been constructed in the department's shop. Many persons not directly interested in magnetism would find it to their advantage to examine the ingenuity and elegance of some of the instrumental details.

The old-fashioned dip circle, with its eccentricities both literal and figurative, has largely given place to the earth inductor. Nothing is said about trouble from thermo-electric cur-

rents in the use of the latter instrument, though due precautions must have been taken to avoid any possible error from this source. It is unfortunate that the Kelvin type of galvanometer still has to be retained, in most cases at least, on account of the stray field produced by the permanent magnet of the moving coil galvanometers. Dip values obtained with the earth inductor are now consistent to within about one minute of arc. The corrections for individual dip needles usually amount to very much more than this.

The tabulated results of observations are comprised in about forty pages. The data include geographical position, date, hour, and values of declination, dip, and horizontal intensity, for a very large number of stations in all of the continents, the antarctic regions, and chief island groups. No reduction of values to a common epoch is attempted. Intensities are given in C.G.S. units. Physicists may well question the necessity of introducing, at the headings of columns of horizontal intensity, the special symbol Γ, which, we are told, represents one C.G.S. unit. In the already highly be-symboled state of science would we not better rest content with that "perfectly good" name for the C.G.S. unit, which is also a reminder of the father of the science of terrestrial magnetism, the *gauss*?

In connection with the land observations, instrumental and other assistance has been furnished in cooperation with various organizations and expeditions. The Australasian Antarctic Expedition and the Crocker Land Expedition may be especially named. The observers' field reports are replete with notes of interest to the geologist, botanist, biologist and explorer. If one seeks information concerning selection of firearms, feeding of camels, defense against Bedawins, or canoeing in the Canadian wilderness, he will find it here.

A valuable feature of the book is the detailed description of the research buildings recently erected near Rock Creek Park. The main building is of fireproof construction, and so stable that no perceptible vibration is transmitted to the most sensitive galvanometers, even when the machinery in the basement is running. For work demanding freedom from magnetic disturbances, a separate non-magnetic building has been erected. Those interested in the building and equipment of laboratories of any kind will profit by a study of these carefully planned structures.

The only special researches recorded in this volume are some miscellaneous observations made in Samoa at the time of the solar eclipse of April 28, 1911, and a very detailed description of the comparisons of magnetic standards made at various observatories. The present attainable precision in magnetic observations may be learned from the statement that "the corrections, on absolute standards, for the declination and inclination may be in error by 0′.1 or 0′.2 and for the horizontal intensity by about $0.0001H$."

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SPECIAL ARTICLES

SOME SUGGESTIONS ON METHODS FOR THE STUDY OF NITRIFICATION[1]

During recent years the use of one gram of dried blood, tankage, cotton-seed meal, bone meal, etc., mixed with 100 gm. of soil, has commonly been employed in laboratory studies on nitrification. In some cases as much as 2 per cent. of these materials has been used. On the other hand, a much smaller amount of ammonium sulfate is usually added because of its greater solubility and recognized toxicity to the nitrifying organisms when present in excessive concentrations. The results are frequently stated in terms of the absolute amounts of nitric nitrogen formed rather than in percentages of nitrogen nitrified. Comparisons and conclusions on the relative nitrifiability of nitrogenous fertilizers are commonly made on the basis of evidence obtained in this way.

In the course of studies on nitrification at the University of California Citrus Experiment Station, the writer recently observed a wide range of variation in the nitrification of

[1] Paper No. 20, Citrus Experiment Station, College of Agriculture, University of California, Riverside, Calif.

dried blood in soil from fertilizer plats of an experiment that has been in progress for eight years. In some cases the use of one per cent. dried blood resulted in no nitrification at all in four weeks' incubation, but rather a partial loss of the nitrates originally present. In soil from other plats, however, vigorous nitrification took place. The soil throughout these plats has been derived from disintegrated granite and is quite sandy and very low in organic matter and nitrogen. In view of the extensive use now being made of dried blood, and the scientific interest attached to the subject, an extended study of nitrification in Southern California soils has been undertaken. Such questions as the relative rates of nitrification of dried blood, bone meal, ammonium sulfate, etc., the effects of lime, the influence of organic matter and other factors are being studied. The investigations are still in progress. Certain of the results already obtained, however, seem of sufficient interest to warrant preliminary discussion at the present time. Later, a more complete presentation of the investigation will be submitted.

At the outset it was found that vigorous ammonification of different organic fertilizers took place in all plats studied and that the addition of lime did not greatly affect either ammonification or nitrification. When the conventional amount of nitrogenous materials was added, however, dried blood was not nitrified in soil from certain plats, while bone meal and ammonium sulfate underwent vigorous nitrification. In soil from other plats no such difference was observed. The following results illustrate the difference in nitrification in two plats. 100 gm. of soil in duplicate was employed in each case.

Materials Added	Increase in Nitric. N. p. p. m. Plot B, Unfertilized	Plot U, Manure, Rock Phos. and Legume
1 gm. dried blood	— 2.8	170
1 gm. bone meal	92.8	154
0.15 gm. ammonium sulfate.	67.8	136

Similar observations have been reported from other soils of California.[2]

[2] Lipman and Burgess, Calif. Sta. Bull. 251 and 260, 1915.

It is of interest in this connection that certain plats in the field experiments, from which the above soils were drawn, have been fertilized annually for eight years with dried blood only, and that marked stimulation has resulted in the growth and vigor of the citrus trees, on the one hand, and in the yield of fruit, on the other. For example, the yield during the past two years has been increased more than 100 per cent. by the use of dried blood. Furthermore, a material increase in the nitrate content of the soil is found at the present time wherever dried blood has been applied, indicating that this material undergoes nitrification in the field.

Two questions, therefore, present themselves. First, why should dried blood fail to undergo nitrification in soil from certain plats but be nitrified vigorously in others, while at the same time bone meal and ammonium sulfate are capable of being vigorously nitrified in each? This question seems especially pertinent since ammonification, generally considered to be essential as preliminary to the nitrification of organic substances, takes place actively. Second, why does dried blood undergo nitrification in the field but not in the laboratory?

Entirely satisfactory answers to these questions can not now be given. Some light has been thrown on them, however, as will appear from the discussion below.

While the proportion of dried blood to soil employed in the above experiments was the same as is commonly used in laboratory experiments on nitrification, nevertheless, the possibility that excessive concentrations of dried blood had been employed was at once suggested. In the field experiments an annual application of 1,080 lbs. of dried blood per acre is now being made to certain plats, applied in approximately equal applications in February, April and July. The addition of 1 gm. per 100 gm. of soil, on the other hand, corresponds to an application of 15,000 lbs. per acre, estimating an acre foot at 3,000,000 lbs. and reckoning that the field application becomes incorporated with the soil to a depth of six inches. Accordingly, a series of laboratory

experiments was undertaken, using soil from a number of plats that had been fertilized differently. The samples were drawn on August 14. Varying amounts of dried blood, bone meal and ammonium sulfate were added and the series arranged so as to make possible a fair comparison of the rates of nitrification when approximately equal amounts of nitrogen had been acted upon simultaneously.[3] The following table sets forth a part of the results obtained:

Nitrification[4] with the Use of Varying Amounts of Materials

Nitrogenous Materials Added	Virgin Soil		Plot *M*, Unfertilized		Plot *O*, Fertilized with Manure and Rock Phos.	
	Nitric N Formed P.p.m.	Per Cent. N Nitrified	Nitric N Formed P.p.m.	Per Cent. N Nitrified	Nitric N Formed P.p.m.	Per Cent. N Nitrified
1 gm. dried blood...	−12	0	−16	0	277	20.9
0.25 gm. dried blood	24	7	100	33.3	101	30.6
0.0625 gm. dried blood.....	39	47.3	55	66.6	43	52.1
4 gm. bone meal.....	−10	0	− 1	0	149	8.8
1 gm. bone meal.....	75	17.6	76	17.9	181	42.6
0.25 gm. bone meal.	46	43.3	49	46.1	52	48.9
0.6 gm. am. sul.	−19	0	11	0.8	55	4.3
0.15 gm. am. sul. ...	31	9.8	62	19.5	119	37.5
0.0375 gm. am. sul..	35	44.1	54	68.2	73	92.0

Briefly, it was found that 1 per cent. dried blood failed to undergo nitrification in those soils which had not been consistently fertilized with organic manures and that in some cases 0.5 per cent. was not nitrified. On the other hand, when the concentration was reduced to 0.25 per cent. or less, vigorous nitrification took place in every case. It was found, however, that in most cases increasing percentages of the nitrogen added were nitrified as the amounts of dried blood were decreased down to 0.0625 per cent. Hence it would seem that even 0.25 per cent. dried blood, which is only one fourth the concentration commonly used in laboratory experiments, may inhibit nitrification to some extent in some soils. Similar statements may be made regarding the results obtained from the use of bone meal. The addition of large amounts of this material corresponding approximately to the larger amounts of nitrogen added as dried blood, failed to be nitrified in the same soils that showed inability to nitrify 1 per cent. dried blood. The smaller amounts, however, were actively converted into nitrate, but in no case more actively than similar amounts of nitrogen as dried blood.

In the case of ammonium sulfate, the results show that increasing percentages of the nitrogen were nitrified as the concentration decreased and that this material was most completely nitrified when added in the lowest concentration. Comparing the percentage of nitrification when the materials were added in low concentrations, similar to that employed in field practises, it is interesting to note that with only one exception out of the ten series of studies now made on the subject, ammonium sulfate was nitrified no more vigorously than dried blood, and in every case dried blood was nitrified more actively than such a low-grade nitrogenous material as bone meal. This feature of the results, therefore, is in harmony with common knowledge and experimental data obtained in humid regions. It should be added that other series of studies conducted at a different time, fully verify the above statements. The conclusions seem warranted, therefore, that dried blood will undergo nitrification in these soils fully as actively as the other materials studied, provided *an excessive concentration is not employed.*

The above data also indicate that before field comparisons on the nitrifiability of different materials can safely be drawn, it is neces-

[3] When the experiments were begun the dried blood was thought to contain 13 per cent. nitrogen and the bone meal approximately 3 per cent. Analyses later showed them to contain 13.2 per cent. and 4.25 per cent., respectively. Consequently the amounts of nitrogen added as bone meal were higher than had been intended, but this does not materially modify the conclusions to be drawn, since a wide range of concentrations was provided. The ammonium sulfate was Baker's C.P.

[4] The data represent the increase in nitric N over that found in separate portions of soil incubated for the same time under similar conditions, but without the addition of nitrogenous material. The minus sign (—) indicates loss of nitrate.

sary to study the rates of decomposition in equal and varying concentrations of actual nitrogen. It seems also that if practical conclusions are to be drawn, it is necessary to approximate field conditions, as nearly as possible, in laboratory tests. This point, it seems to the writer, has not been sufficiently recognized in many soil bacteriological studies. The conditions ensuing when relatively large amounts of nitrogenous substances such as dried blood, tankage, etc., undergo decomposition, may conceivably become extremely abnormal and greatly dissimilar to those ensuing under field practise. The products arising from the decomposition of 1 per cent. dried blood, under some conditions of bacterial activity may exert, either directly or indirectly, important influences on the further action of the micro-organisms present. Such, for example, is known to be the case in the bacterial decomposition of milk. In fact the course and extent of many chemical and biochemical reactions is known to be greatly modified by the products of the action.

As stated above, dried blood undergoes vigorous ammonification in the several plats studied. It has been suggested that the conditions produced by the high concentrations of ammonia or ammonium carbonate, formed from the larger amounts of dried blood and bone meal, may have been unfavorable to the activity of the nitrifiers. With the hope of securing light on this point, preliminary studies have been made by adding varying amounts of ammonium hydrate and ammonium carbonate in addition to 0.25 per cent. dried blood, using a soil in which no nitrification of 1 per cent. dried blood takes place. The results showed that in every case the addition of either ammonium hydrate or ammonium carbonate partially inhibited nitrification even in the low concentration of 5 mg. per 100 gm. soil. Whether the ammonia was actually toxic to the nitrifying organisms, or reacted unfavorably through physical effects produced or otherwise, can not be definitely stated at the present time.

Evidence has been obtained that there is considerable seasonal variation in regard to the inhibiting effect of 1 per cent. dried blood. With samples drawn from one plat in April and June, respectively, 1 per cent. dried blood underwent active nitrification, while no nitrification took place in samples taken August 14. In each case 0.5 per cent. and less were actively nitrified. Whatever may be the cause of this phenomenon, the fact still remains to be explained that 1 per cent. dried blood brought about toxic conditions in certain plats, but not pronouncedly so in others.

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SOME EXPERIMENTS WITH AGENTS CALCULATED TO KILL THE TROMBIDIUM HOLOSERICEUM

THE *Trombidium holosericeum* or common chicken mite is present in most hen houses throughout the country. It is very troublesome in the hotter months, especially July and August, when it finds climatic conditions favorable for its more rapid multiplication. The mites hide in clusters, in the cracks and crevices of the roost pole and in the crack where the roost pole rests on its support. Here they lay their eggs and the young and old emerge to attack the chickens at night.

The mite finds its way to the hen at night and with its conical piercing apparatus attacks the skin and draws blood. After its feast it leaves the hen and returns to its hiding place.

In searching the literature at hand in the library of the office of poultry investigations and pathology of this station no trace could be found where scientific tests and records had been made to determine just what effect the various parasiticides have upon mites.

There is common belief that tobacco clippings, sulphur, paris green, and a host of liquids are great destroyers of these formidable foes of the poultry house, but no one so far as we could find has actually made the tests. It was thought best to try a score of the more common agents used and to run duplicate tests.

Mode of Tests.—The tests were run either in open tumblers or sauce dishes so as to have an abundance of air present and to have the

tests as nearly under normal conditions as possible.

Agents Used.—The agents used fall into three classes, namely: Powders not giving off gas, powders that give off gases, and liquids. Tests were run with sulphur, air-slaked lime, paris green, naphthalene, gasoline, carbolic acid, insect powder, tobacco stems and dust, crude carbolic acid, 5 per cent. carbolic acid, 1 per cent. kreso dip, 2 per cent. kreso dip, 5 per cent. naphthalene in kerosene and 10 per cent. formaldehyde.

Sulphur.—Air-slaked lime was placed in the bottom of a tumbler. At the end of 24 hours, the mites had accumulated in a cluster in the center of the dry lime. Upon being poured out upon a paper they were still found to remain vigorous. Dry air-slaked lime has apparently no injurious effect upon them.

Paris Green.—Dry paris green (powder) was placed in the bottom of a tumbler and several hundred mites placed in the powder and stirred up. At the end of 48 hours the mites had formed in a cluster in one edge of the powder. Upon being removed they were found to be as vigorous as before being placed in the paris green. Dry paris green has apparently no ill effect upon mites.

Naphthalene (Powdered Moth Balls).—A quantity of pulverized moth balls was placed in the bottom of a tumbler and several hundred vigorous mites placed on the surface. At the end of 30 minutes motion was not so active and at the end of 45 minutes all motion ceased. Upon being removed and placed upon paper all mites were found to be dead.

Tobacco Bits.—Bits of tobacco leaves, the sweepings from the floor of a tobacco factory, were placed in the bottom of a tumbler and several hundred very active mites placed among the tobacco. Frequent observations were made and at the end of 72 hours the mites were as active as when they were placed in the tumbler.

Insect Powder.—A powder prepared in this laboratory consists of gasoline three parts, crude carbolic acid 1 part, and plaster of paris sufficient to make a rather dry mixture. This was passed through a sieve on to paper and after one hour was placed in tight jars till needed. A quantity of this powder was placed in the bottom of a tumbler and several hundred active mites placed in the material and mixed with it. At the end of one minute all mites were dead.

Five Per Cent. Carbolic Acid Solution in Water.—A quantity of a five-per-cent. aqueous solution of carbolic acid was poured out into a saucer and several hundred mites placed on one side, and the dish then tilted till all the mites were wet, then the liquid drained from them, the mites remaining on the wet surface for observation. In 30 seconds all mites were dead.

One Per Cent. Naphthalene in Kerosene.—One per cent. powdered moth balls dissolved in kerosene was tested. A quantity of this fluid was poured into a saucer and several hundred mites placed on the opposite side of the saucer then immersed as in the preceding test. In 30 seconds all mites in test were dead.

Crude Carbolic Acid.—Crude carbolic acid was poured into a saucer and several hundred mites placed on one side were immersed as in the preceding test. In 20 seconds all mites in the test were dead.

One Per Cent. Kreso Dip.—This liquid was poured into a saucer and several hundred mites subjected as in the preceding tests. At the end of four minutes motions slowed and at the end of ten minutes all mites in the test were dead.

Two Per Cent. Kreso Dip.—Test conducted as the preceding. At the end of two minutes motion was retarded and all mites in the test were dead at the end of four minutes.

Ten Per Cent. Formaldehyde.—The test was conducted as in the preceding. At the end of ten minutes all the mites in the test were dead.

Summary

Duplicate tests were run to determine the action, if any, of powdered sulphur, air-slaked lime, paris green and naphthalene upon the *Trombidium holosericeum* (the chicken mite).

It was found that though sulphur in solution as in lime and sulphur dip is an efficient parasiticide, that although paris green in solu-

tion is a violent poison because of its arsenic content and although tobacco leaves contain nicotine which when in solution is an effective parasiticide, yet these agents in their dry state do not destroy mites.

Duplicate tests were run with naphthalene or powdered moth balls which on account of its volatile substances emitted, killed all mites in the tests in 45 minutes.

Insect powder containing gasoline and crude carbolic acid, on account of the volatile substances given off, killed all mites in one minute.

In duplicate tests, solutions sufficiently concentrated killed in the following lengths of time: Crude carbolic acid, 20 seconds. Five per cent. carbolic acid, one minute. One per cent. naphthalene in kerosene, 30 seconds. One per cent. kreso dip ten minutes and two per cent. four minutes. Ten per cent. formaldehyde ten minutes.

Conclusions

In order that parasiticides be effective in the destruction of the mites they must either be in solution or be capable of giving off volatile substances which in themselves are destructive.

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THE GROWTH OF BONE IN CRETACEOUS TIMES

PALEONTOLOGISTS have, for many years, been acquainted with the curious conical portions of young plesiosaurian propodials and, also, they have observed definite openings on the edges of many of the flattened limb bones. One of these openings has, in some cases, been observed to lead into a canal, which, in turn, passes into a cavity, remarkably like the medullary canal of mammalian long bones. There has never been an adequate explanation for these curious conditions.

It has been generally assumed that the unusual characters mentioned above have been confined to the propodium (humerus or femur) but, recently, in studying the osteology of an immature plesiosaur from the Cretaceous, the writer noted all of these characters in a phalangeal bone. Further study of this problem will doubtless result in the discovery of these characteristics in all the long bones of the skeleton, especially in young and immature animals.

Andrews, Williston, Lydekker, Kiprijanoff and the writer have remarked on the unusual characters of this ancient group of aquatic reptiles and an attempted explanation[1] has been given of the curious conical ends of young propodials which formerly were regarded as epiphyses.

In regard to the openings, canal and cavity, the writer believes an adequate explanation of this condition is to be found in the developmental history of the mammalian long bones. Szymonowicz[2] has figured in a developing long bone of a mammal an opening which he terms "periosteal bud," similar in all respects to the opening in the edge of plesiosaurian limb bones. In both cases a canal leads from the foramen into the medullary cavity.

Jackson[3] has given a careful description and figure of a similar condition in the tibia of a three-day cat. Through this opening the blood vessels supplying the medullary cavity, the osteoblasts and marrow-forming elements migrate from the periphery into the medullary cavity.

Bidder[4] has further studied the conditions of bone formation and his contribution has suggested an explanation for certain curious features in the propodials of the plesiosaurs. The question arises as to whether it is legitimate to interpret developmental factors in the ancient reptiles from what occurs in modern mammals. That question is not yet settled, but assuming that an analogy may be safely drawn between developmental features in the

[1] Moodie, Roy L., "Reptilian Epiphyses," *Amer. Jour. Anat.*, Vol. 7, No. 4, pp. 443–467, Figs. 1–24, 1908.

[2] Szymonowicz, L., "A Text-book of Histology and Microscopic Anatomy of the Human Body," trans. by MacCallum, 1902, p. 270, Plate XXIX.

[3] Jackson, C. M., *Archiv für Anat. u. Physiol., Anat. Abth., Jahrg.*, 1904, p. 33, Taf. VII., Fig. 1.

[4] Bidder, Alfred, 1906, "Osteobiologie," *Archiv f. mikros. Anat.*, Bd. 68, pp. 137–210, Taf. X–XIV.

two groups we may use the facts, in the works above referred to, to explain conditions in the Cretaceous plesiosaurs which are inexplicable on any other grounds.

The limb bones of adult plesiosaurs are solid. Young bones nearly always exhibit the canal, cavity and one or more of the foramina above referred to. The fact that the bones are first hollow and later become solid would seem to indicate that the osteolytic elements present in the limb bones of mammals and most reptiles were almost absent, or present in small numbers, in the plesiosaurs and many of the larger dinosaurs.

If the comparison between the developing limb bones of mammals and reptiles is a safe one, then we have here in the young aquatic plesiosaurs of the Cretaceous a condition which persisted until late in life and which recurs in the young of all mammals at the present day. One species of plesiosaur, based on an immature skeleton of an animal some fifteen feet in length, exhibits these conditions in a well-marked manner. Through the openings in the edges of the limb bones of the plesiosaurs, as in the mammals, migrated the osteoblasts or bone-forming cells, the blood vessels and other elements.

The peripheral or perichondral bone was formed first in the plesiosaurs as in the modern mammals, and, through the migration of the bone-forming cells inward, the so-called endochondral bone was a secondary formation. The formation of bone within the endochondrium of the plesiosaurs was, apparently, retarded by some osteolytic agent, possibly the osteoclasts, until the bone-forming elements for some unknown reason attained the supremacy and completely filled the medullary cavity, canal and foramen with solid bone. During this process of filling there resulted, in young bones, a sharp line of separation of the perichondral from endochondral bone, resulting in the formation of curious conical end pieces, formerly called epiphyses, but now known to be the result of bone growth and not epiphyses at all.

Bidder[4] has offered an interesting explanation of the formation of epiphyses in mammals, by the migration of the osteoblasts through special vascular canals (*Canalis vasculosis perforans*) which traverse the space between the medullary cavity and the cartilaginous caps at the ends of the limb bones.

It is interesting to observe in broken and sectioned plesiosaurian propodials an exactly similar condition for this ancient group of aquatic reptiles. The canals are found extending from the medullary cavity to the ends where the bone has been formed in the shape of small conical mounds around the vascular openings, so that in the plesiosaurs the process resulted not in the production of new growths at the ends of the limb bones (epiphyses) but in the elongation of the bone. It is hoped in another place to give a fuller explanation and figures of these interesting relics of Mesozoic osteogenesis.

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THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The regular meeting just held at Columbus (December 27 to January 1) was one of the most successful of the recent meetings of the association. All of the sessions were held in the buildings on the campus of the Ohio State University and members of the association who attended the Columbus meeting of 1899, and who had not visited the university since were surprised and delighted at the enormous growth of the institution and at the character of the many new buildings which had been built since that day. The local committee in charge of the arrangements was extremely efficient and the compactness of the group of buildings and the exceptional meeting room facilities made everything easy for members in attendance.

The opening night for addresses of welcome and for the annual address of the retiring president was in many respects the most impressive function of the kind held under the auspices of the association in the recollection of the writer. In spite of a stormy night the college chapel, seating about 1,200 persons, was completely filled. The address of welcome by President W. O.

Thompson, of the university, and Dr. T. C. Mendenhall, past-president of the association, were extremely happy. Dr. Thompson welcomed the association on the part of the university, city and the commonwealth, and Dr. Mendenhall, finding that his predecessor had included practically all Ohio of to-day in his address, welcomed the association on the part of the shades of deceased Ohio men of science, sketching briefly the career of a number of Ohio's great men of science of the past century. President Eliot's address entitled "The Fruits, Prospects and Lessons of Recent Biological Science" was published in the last number of SCIENCE.

Following the opening meeting a crowded reception was held in the beautiful new library building.

Owing to the death of Retiring Vice-president F. W. Taylor, of Section D, and the absence of Retiring Vice-presidents U. S. Grant, of Section E, and Edgar F. Smith, of Section C, there were no vice-presidential addresses delivered before these sections. The address of Retiring Vice-president Clark Wissler, of Section H, on "Psychological and Historical Interpretations of Culture" and that of R. M. Pearce, of Section K, on "The Work and Opportunities of a University Department for Research in Medicine" were read by title and will be published in SCIENCE.

Addresses by retiring vice-presidents were delivered as follows:

Section A: H. S. White, "Poncelet Polygons."

Section B: Anthony Zeleny, "The Dependence of Progress in Science upon the Development of Instruments."

Section F: F. R. Lillie, "The History of the Fertilization Problem."

Section G: G. P. Clinton, "Botany in Relation to American Agriculture."

Section I: Elmer E. Rittenhouse, "Upbuilding American Vitality, the Need for a Scientific Investigation."

Section L: Paul H. Hanus, "City School Superintendents' Reports."

Section M: L. H. Bailey, "The Forthcoming Situation in Agricultural Work."

There were three public lectures complimentary to the citizens of Columbus. On Tuesday night, Dr. Douglas W. Johnson, "Surface Features of Europe as a Factor in the War." Wednesday night, by Dr. Raymond F. Bacon, Mellon Institute of Pittsburgh, "The Industrial Fellowships of the Mellon Institute: Five Years' Progress in a System of Industrial Service." Friday night, by Dr. Frank K. Cameron, of the Bureau of Soils, Washington, "The Fertilizer Resources of the United States."

The council after an extended discussion adopted the recommendation of the committee on policy to the effect that members of the affiliated societies including the component societies of the old Pacific Association of Scientific Societies, not now members of the Amerian Association, be invited to join the American Association during the year 1916, without payment of the usual entrance fee of $5.00.

Two amendments to the constitution were introduced and will be acted upon at the next annual meeting.

1. Amend Article 22 of the constitution by omitting after the word "Chemistry" in the second line, the words "including its application to Agriculture and Arts."

2. Amend Article 9 of the constitution by adding in line 8 after the words "Permanent Secretary," the words "and the Secretaries of Sections." This amendment, if adopted, will permit the reelection of secretaries of sections, after the expiration of the five-year term and seems especially desirable in case of secretaries who are willing to continue the work.

Dr. Chas. Henry Hitchcock, Dr. Eugene W. Hilgard and Rev. Louis C. Würtele were made life members under the Jane M. Smith fund.

Dr. J. McK. Cattell, Dr. W. J. Humphreys and Professor H. L. Fairchild were reelected members of the committee on policy.

There was, unfortunately, only a small attendance at the meeting of the committee of one hundred on research, and but one report was presented, namely, that by Professor C. R. Cross, chairman of the subcommittee on research funds.

The societies which meet at Columbus in affiliation with the American Association were: American Association of Economic Entomologists; American Mathematical Society; American Microscopical Society; American Nature Study Society; American Physical Society; American Phytopathological Society; American Society of Naturalists; Association of Official Seed Analysts of North America; Botanical Society of America; Entomological Society of America; Society for Horticultural Science; Southern Society for Philosophy and Psychology; Students and Collectors of Ohio Archeology; Wilson Ornithological Club.

The total registration at the association office was seven hundred and fifty, making the meeting one of the largest of the second group. The geo-

graphic distribution of members and attendants was interesting, Ohio naturally leading with one hundred and eighty-one. The other figures are as follows: New York, 59, Michigan 27, Massachusetts 24, Minnesota 18, Missouri 14, District of Columbia 32, Illinois 63, Indiana 34, Iowa 22, Kansas 17, Pennsylvania 31, Wisconsin 25, West Virginia 10, and other states represented by less than 10.

Owing to the impossibility of securing perfect registration, the accurate number of scientific men and women in Columbus can not be stated, but it is safe to say that it approximated nine hundred.

Much interest was shown at the meeting by the citizens of Columbus, and the meetings of all the sections and affiliated societies were extremely well attended. The smokers and dinners were all successful.

The symposia of the meeting were as follows:

Before Section F and the American Society of Zoologists on the topic "The Basis of Individuality in Organisms," the speakers being C. M. Child, E. G. Conklin, O. C. Glaser, C. E. McClung and H. V. Neal.

Before the American Society of Naturalists on the topic "Recent Advances in the Fundamental Problems of Genetics," the speakers being H. H. Bartlett, W. L. Tower, E. M. East, H. S. Jennings and C. B. Davenport.

Before Section I, topic "National Defense and Development," there being twelve speakers.

Before Section K, topic "The Energy Content of the Diet," the speakers being H. P. Armsby, Ruth Wheeler, E. B. Forbes, Carl Voegtlin and C. F. Langworthy.

Before Section M, topic "The Relation of Science to Meat Production," the speakers being W. O. Thompson, H. J. Waters, L. D. Hall, H. W. Mumford and A. R. Ward.

In spite of the fact that the Geological Society of America was meeting in Washington with the Pan-American Congress at the same time, Section E held a very important meeting at which twenty-nine papers were presented, topics relating to the geology of Ohio and adjoining states predominating.

The council passed a resolution to hold a special meeting of the American Association for the Advancement of Science in Washington on January 4, 1916.

Two grants were made by the council, one of one hundred dollars to R. C. Benedict, of Brooklyn, to assist in his investigation of the plants of the fern genus *Nephrolepis*, and one of two hundred and fifty dollars to the Concilium Bibliographicum Zoologicum of Zurich.

A list of the fellows elected will appear in a near number of SCIENCE.

The arrangements for the entertainment of the visiting ladies were exceptionally pleasant and in the resolutions of thanks, which were passed by the council, especial attention was drawn to the admirable work of the ladies' committee, of which Mrs. W. O. Thompson, wife of the president of Ohio State University, was chairman. A very interesting feature was a twilight musical recital with a MacDowell program, which was given on Wednesday afternoon.

Election of officers by the General Committee resulted as follows:

President: C. R. Van Hise, University of Wisconsin.

Vice-presidents as follows: Mathematics, L. P. Eisenhart, Princeton University; physics, H. A. Bumstead, Yale University; engineering, E. L. Corthell, Brown University, Providence, R. I.; geology and geography, R. D. Salisbury, University of Chicago; zoology, G. H. Parker, Harvard University; botany, T. J. Burrill, University of Illinois; anthropology and psychology, F. W. Hodge, chief of the Bureau of Ethnology, Washington, D. C.; social and economic science, Louis I. Dublin, New York; education, L. P. Ayres, of the Russell Sage Foundation, New York; agriculture, W. H. Jordan, director of the New York State Experiment Station, Geneva, N. Y.

The vice-presidents of Sections C and K were not elected, but power was given to the sectional committees to elect. Professor W. E. Henderson, of Ohio State University, was elected general secretary and Dr. C. Stuart Gager was made secretary of the council. Dr. A. F. Blakeslee was elected secretary of Section G and Mr. S. C. Loomis, secretary of Section I.

New York was selected as the place for the Convocation Week meeting of 1916–17, the opening meeting to be held on the night of December 26, and the first council meeting on the morning of December 27, 1916.

The general committee recommended to the general committee of next year the selection of Pittsburgh as the meeting place for 1917–18.

In the absence of the general secretary, Dr. Henry Skinner, of Philadelphia, Dr. Henry B. Ward, of Urbana, acted as general secretary, but the present brief report of the meeting has been drawn up by the permanent secretary.

L. O. HOWARD

SCIENCE

FRIDAY, JANUARY 14, 1916

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE HISTORY OF THE FERTILIZATION PROBLEM[1]

WE come together at this season of the year to discuss the latest advances in our science and to listen to the announcement of new discoveries. This implies a philosophy of life, an optimistic philosophy; we would not work as individuals nor assemble as societies if we did not believe that science is worth while, and that human progress is both possible, and, for some inscrutable reason, worth working for. This was the philosophy of science in the time of the Greeks, and it is the philosophy of our science of scarce four hundred years' growth. Modern science, I need hardly say, was entirely European in its origin, as is our American scientific population; and all science is ours to promote and advance by right of inheritance no less than of intellectual sympathy. Now that the great war is so largely arresting the progress of science in Europe it is our bounden duty to see that there is no halting in America; we should hold fast to our faith and strengthen our efforts for the advancement of science.

As we all labor for progress in science, I thought it would not be entirely out of place if, instead of dealing with some new subject, I attempted to lay before you a picture of the total progress in some central problem of biology; it can be nothing more than a sketch, but it may perhaps

[1] Address delivered before the American Society of Naturalists, and the Zoological Section of the American Association for the Advancement of Science, December 30, 1915.

help to justify our faith, and also to temper our conceit, if we have any. Fertilization is such a central problem which has interested mankind from the dawn of reasoning on account of its fundamental character, and is more or less interwoven with the thought of all ages.

Aristotle and Harvey.—It must be remembered in beginning our topic that the problem of fertilization was not clearly separated from the general problem of reproduction until well into the nineteenth century. In early human culture reproduction received its only interpretation at the hands of priests and mystery men; its first philosophical and scientific treatment was one of the great distinctions of the Greeks, especially of that great philosopher and father of science, Aristotle, who combined observation and reflection in the interpretation of nature. Aristotle devoted a separate treatise, which has come down to us, to animal reproduction. Among other things he studied the development of the chick day by day with so much detail that Harvey felt impelled to say, 1,900 years later:

> Aristotle among the ancients, and Hieronymus Fabricius of Aquapendente, among the moderns, have written with so much accuracy on the generation and formation of the chick from the egg that little seems left for us to do.

From the time of the Greeks to that of Harvey (1651) there was but little progress in the knowledge of reproduction, and none in the theory, as will appear from the views of Aristotle, the current views of medical men of Harvey's time, and of Harvey himself. Aristotle says:[2]

> The male is the efficient agent, and by the motion of his generative virtue (genitura), creates what is intended from the matter contained in the female; for the female always supplies the matter, the male the power of creation, and this it is which constitutes one male, another female. The body and the bulk, therefore, are necessarily supplied by the female; nothing of the kind is required from the male; for it is not even requisite that the instrument, nor the efficient agent itself, be present in the thing that is produced. The body then proceeds from the female, the vital principle (anima) from the male; for the essence of every body is its vital principle (anima).

With more common sense, if with less metaphysical subtlety, the physicians of the Middle Ages held, according to Harvey, that conception is due to a mingling of male and female seminal fluids,

> the mixture having from both equally the faculty of action and the force of matter; and according to the predominance of this or that geniture does the progeny turn out male or female (quoted from Harvey, Ex. 32).

Harvey's observations contained much that was new and significant, but the facts that he knew were inconsistent both with Aristotle's ideas and those of the physicians. They were, however, inadequate for sound generalization.

> Wandering between two worlds, one dead
> The other powerless to be born,

he descended deeper into the slough of metaphysics than Aristotle, and committed himself to the fantastic idea that conception in the uterus is identical with, or at least analogous to, conception in the brain; and that the ovum is the product of such unconscious uterine desire or conception, and receives no material substratum from the male![3] The theory of reproduction

[2] "De Gen. Anim.," lib. II., cap. 4, quoted from Harvey "On the Generation of Animals," Ex. 29.

[3] "Since there are no manifest signs of conception before the uterus begins to relax, and the white fluid or slender threads (like the spider's web) constituting the 'primordium' of the future 'conception' or ovum, shows itself; and since the substance of the uterus, when ready to conceive, is very like the structure of the brain, why should we not suppose that the function of both is similar, and that there is excited by coitus within the uterus a something identical with, or at least analogous to, an 'imagination' (phantasma) or a 'desire' (appetitus) in the brain, whence comes

was no whit more advanced in the middle of the seventeenth century than in the time of Aristotle.

The Period of Leeuwenhoek.—The use of the microscope in biological research began in the seventeenth century; it was the improvement of this new instrument of investigation and its application to the study of the reproductive substances that furnished the first fundamental advance in the theory of reproduction at the hands of Leeuwenhoek, viz., the discovery of the spermatozoa[4] in 1677.

This discovery aroused the greatest interest in scientific circles; a number of investigators repeated the observations and a spirit of speculation which led to wild flights of the imagination was aroused. Leeuwenhoek had soon to defend his priority in the matter and to protest against certain very imaginative views. Thus in a letter dated June 9, 1699,[5] he defends his priority and combats the notion that the human form can be observed in the spermatozoa. He inveighs especially against a certain Dr. Dalen Patius, who claimed to have seen the human form,

the two naked thighs, the legs, the breast, both arms, etc., the skin being pulled up somewhat higher did cover the head like a cap.

Leeuwenhoek states that he can find nothing of the sort, but he adds:

I put this down as a certain truth, that the shape of the human body is included in an animal of the masculine seed; but that a man's reason shall dive or penetrate into this mystery so far, that in anatomizing one of these animals of the masculine seed we should be able to discover the entire shape of the human body, I can not comprehend.

In a letter dated two weeks later he distinguishes two sorts of these animalcules, and concludes that the one sort is male and the other female.

this observation and repeated it many times. In this letter he gives a fair description of the spermatozoa, their form, size and movements and stated that he had observed them three or four years previously and mistaken them for globules. He did not at this time speculate as to the meaning of the spermatozoa, but in true scientific spirit began to make comparative observations, and in 1678 he described and figured spermatozoa of the rabbit and frog among others.

The credit of this discovery seems to me to belong rightly to the investigator whose wide experience in the field of microscopical anatomy and whose scientific acumen enabled him to grasp the possible significance of the discovery; not to the chance observer who called Leeuwenhoek's attention anew to the subject.

the generation or procreation of the ovum. For the functions of both are termed 'conceptions,' and both, although the primary sources of every action throughout the body, are immaterial, the one of natural or organic, the other of animal actions; the one (viz., the uterus) the first cause and beginning of every action which conduces to the generation of the animal, the other (viz., the brain) of every action done for its preservation. And just as a 'desire' arises from a conception of the brain, and this conception springs from some external object of desire, so also from the male, as being the more perfect animal, and, as it were, the most natural object of desire, does the natural (organic) conception arise in the uterus, even as the animal conception does in the brain.

"From this desire or conception, it results that the female produces an offspring like the father. For just as we, from the conception of the 'form' or 'idea' in the brain, fashion in our works a form resembling it, so, in like manner, the 'idea' or 'form' of the father existing in the uterus generates an offspring like himself with the aid of the formative faculty, impressing, however, on its work its own immaterial 'form'" (from William Harvey, "On Conception," 1651).

[4] This discovery is sometimes credited to Hamm, described as a student of Leeuwenhoek's. The latter himself describes the occurrence as follows (*Phil. Trans.*, 1678, containing a letter from L. dated November, 1677): A certain Professor Cranen, who had frequently visited Leeuwenhoek for microscopical demonstration, requested by letter that he should give Dominus Hamm, a relative of his, some demonstrations of his observations. On his second visit D. Hamm brought in a glass vial some seminal fluid and stated that he had observed living animals in it; Leeuwenhoek confirmed

[5] *Phil. Trans.*, Vol. 21.

In France in the year of 1694, Nicholas Hartsoeker claimed to have been the first to have discovered the spermatozoa more than twenty years previously, although he did not publish until 1678, a year later than Leeuwenhoek's publication. Hartsoeker's ideas are characterized by a high degree of precision. He believes that each spermatozoon conceals beneath its "tender and delicate skin" a complete male or female animal, "which would perhaps appear if it could be seen like the following figure."[6] The egg is merely a source of nourishment for the real germ contained in the spermatozoon. In birds the spermatozoon enters an egg to be nourished; there is but a single opening in the egg, situated over the so-called germ, and this opening closes after a single spermatozoon is admitted; but if two spermatozoa enter they unite and form a double monster. In mammals the tail of the spermatozoon is the umbilical cord; this unites with the ovum, *i. e.*, the placenta, and the latter with the uterus. Each one of male animals (spermatozoa) encloses an infinity of other animals both male and female, which are correspondingly small, and those male animals enclose yet other males and females of the same species, and so forth in a series which includes all the members of the species which are to be produced up to the end of time. No difficulty was found in this conception, for the atomic theory of matter was not yet placed on a scientific basis.

Thus was founded and flourished for its brief day the school of the spermatists. Unhampered by any scientific conception of matter, living or non-living, there was no obstacle to the eye of faith and no impediment to the age-old longing to make an intelligible universe out of the scraps of experience.

[6] The figure in question is reproduced in Kellicott's General Embryology, p. 22.

The Period of Spallanzani.—In the entire eighteenth century, although speculation continued rife, there was only one notable contribution to our subject. This was the work of the Abbé Spallanzani, "Expériences pour servir à l'histoire de la génération des Animaux et des Plantes," published in Geneva in 1785. His working hypotheses were naturally in the spirit of the times. Theories of reproduction, he says, may be reduced to two.

> The one explains the development of organisms mechanically, the other supposes them to preexist, and waiting only for fertilization to develop them. The second system has given birth to two different parties, one believing that the organism is preformed in the ovum, the other that it is preformed in the spermatozoon.

Spallanzani believed that his observations destroyed the epigenetic theory as propounded by Buffon and others, because they demonstrated the existence of the fetuses (ova) in the females of toads, frogs and salamanders, prior to the act of fertilization, which according to the epigenesists animates or creates the germ. For the same reason the spermatists must also be wrong. Spallanzani thus combated epigenesis as understood in the eighteenth century, and also the ideas of the spermatists, and he was led to deny that spermatozoa are necessary for fertilization, and to hold that the fertilizing power of the seminal fluid resides not in the spermatozoa, but in the fluid medium that accompanies them; and this in spite of the fact that his final experiments really proved the reverse.

His work contains a great wealth of observation and experiment, so that it will be possible merely to indicate some of his chief results. In the first place he demonstrated that in frogs and toads fertilization takes place outside of the body, and for the first time he successfully carried out artificial insemination, thus laying the foundation for the artificial propagation of many ani-

mals. In making these experiments he thought he found cases in which seminal fluid devoid of spermatozoa would fertilize and thus fell into the error, which he was so ready to accept from his opposition to the spermatists, that the fluid medium of the seminal fluid was the fertilizing substance. He also investigated the conditions of successful insemination, with reference to the duration of fertilizing power, exposure to various chemicals, to heat, etc. The amount of dilution of which the seminal fluid was capable was also carefully investigated. By experiment he excluded the idea that fertilization might be an effect of an emanation, or vapor arising from the sperm.

He concluded that the seminal fluid acted by accelerating the vital processes; it enters the body through pores, and stimulates the action of the heart. This idea offered no difficulty to one who believed that the organism was preformed in the ovum, and it was supported by the observation that the beating of the heart was the first observable movement of the embryo. Bonnet suggested to him the problem, if the spermatic fluid might stimulate the heart of the embryo in the process of fertilization, why might not other fluids produce the same effect? He was thus led to attempt the first experiments on artificial parthenogenesis; he tried to start the development of eggs by electricity, by the action of extracts of all the various organs, by vinegar, dilute alcohol, lemon juice, and other substances, all without effect.

It is interesting to see how his experiments led to hypotheses and these, even though wrong, to further experiments, some of which, like his experiments on artificial parthenogenesis, were not taken up again in a fruitful way for over a century.

His final experiments are those so often quoted as furnishing the proof that fertilizing power resides in the spermatozoon. He showed that, if diluted sperm be filtered through a sufficient number of layers of filter paper, the filtrate has no fertilizing power, whereas the residue washed off the filter paper will fertilize. But he did not himself draw the correct conclusion; he says the experiment proves "that filtration removes from spermatized water its fertilizing power, inasmuch as the seminal fluid which was contained in it remains on the filter papers, from which one can extract it by pressing them." It is perfectly clear that Spallanzani himself never held that the spermatozoa themselves were the fertilizing agents, but, on the contrary, he contests this idea strongly as leading to spermatist delusions.

1800–1870.—After Spallanzani there was no real advance in the theory of fertilization until the publication of Prevost et Dumas' "New Theory of Reproduction" in 1824. They observed that young animals incapable of breeding, old animals beyond the breeding stage, the infertile mule, and birds outside of the breeding season possess no spermatozoa, and they conclude that these facts "sufficiently prove the importance of the animalcules, and show that there exists an intimate relationship between their presence in the reproductive organs and the fertilizing power of the animal." In a long series of experiments they investigated the conditions of fertilization in frogs: all conditions that destroy the animalcules destroy also the fertilizing power of sperm suspensions; the filtrate of a sperm suspension devoid of spermatozoa will not fertilize; the redissolved residue of a suspension evaporated to dryness will not fertilize, etc.; the number of eggs fertilized is always less than the number of animalcules employed. So that they came to the conclusion that "the prolific principle resides in the spermatic animalcules."

In their subsequent publications they concluded that it is

> infinitely probable that the number of animalcules employed in fertilization corresponds to that of the embryos developed . . . so that the action of these animalcules which we regard as the male reproductive elements is individual, not collective.

They concluded that a spermatozoon penetrates each egg and becomes "the rudiment of the nervous system, and that the membrane (germ disc of the egg) in which it is implanted, furnishes, by the diverse modifications which it undergoes, all the other organs of the embryo."

These studies gave a new impetus to the study of fertilization; some were convinced that Prevost et Dumas were essentially correct, while others still adhered to the idea that the fluid part of the seminal fluid was the fertilizing medium. Thus the celebrated embryologist Bischoff in 1842 does not hesitate to declare outright for the latter view "that only the dissolved part of the semen penetrates into the egg and thus completes fertilization." He considered that

> Valentin's hypothesis united all the facts; the seminal fluid is so unstable chemically as to break down as soon as the particles come to rest; it is similar to the blood in this respect, but it is not in regular circulation and the function of maintaining its chemical composition is relegated to the movements of the spermatozoa.

However, Bischoff subsequently became convinced that the spermatozoa were themselves the essential agents, though he still refused to believe in the penetration of the egg. Kölliker had put forward a contact theory of fertilization, which Bischoff regarded merely as a statement of facts requiring further development. He therefore adopted the idea of catalyzers, at that time a new idea in chemistry, and held that the spermatozoon was essentially a catalytic agent, *i. e.*, as he defined it, "a form of matter characterized by definite transformation and internal movement" which it transmits by contact to the egg, which is in a condition of maximum tension or inclination to assume the same form of transformation and movement. Fertilization is thus not a process of union and fusion as in ordinary chemical combination, but a catalytic process, as defined above.

This point of view deserves to be emphasized as one of the first attempts at a physico-chemical explanation of fertilization.

For some time naturalists were divided between the two points of view, viz., that of Prevost et Dumas, that the sperm penetrated into the egg, and that of Kölliker and Bischoff that it acted by contact. Lallemand (1841) well expresses the view of those who believed in the union of the ovum and spermatozoon:

> Each of the sexes furnishes material already organized and living. . . . A fluid obviously can not transmit form and life which it does not possess. . . . Fertilization is the union of two living parts which mutually complete each other and develop in common. . . . When one embraces in a single point of view the reproduction of all living beings, one arrives at the following more general formula: Reproduction is the separation of a living part which may either develop separately or acquire from another living part the supplementary elements necessary for the ulterior development of a being similar to the type. . . . The preservation of the type is due to the extension of the same act which has produced the development of each individual being.

This is the most complete statement of the principle of genetic continuity that I have found in the literature of this period.

These observations and conclusions were found on the eve and early morrow of the greatest biological generalization, the cell-theory. Though Schwann interpreted the ovum as a cell (1838), this view did not at once become dominant, and was generally accepted only after over twenty years of discussion. The view that spermatozoa were parasitic organisms was more or less

current until Kölliker in 1841 showed by their development that they were modified cells. Nevertheless, there was, strictly speaking, no immediate application of these results to the problems of fertilization.

The half century from 1824 to 1874 yielded relatively little advance in fertilization theory; the opinion that the spermatozoon actually penetrated into the ovum gradually gained ground largely from the very logic of the situation, but partly from various observations. Bischoff's contact theory, which was the only alternative, was criticized because if the sperm does not penetrate, but remains outside of the membrane, there is absence of that direct contact between sperm and egg substance postulated by the theory. Wagner's criticism was also very effective; a ferment does not determine the character of a reaction, but the spermatozoon does, for it transmits paternal characteristics. In the way of observations Barry in 1840, Newport,[7] 1854–1855, Meissner, 1855, and others maintained observations of penetration of the ovum by the spermatozoon; Keber (1854) laid especial emphasis on the micropyle as adapted for entrance of a spermatozoon. These observations were on the whole inconclusive, for actual penetration was not observed, but inferred from the presence of spermatozoa inside the egg membrane. Moreover, the spermatozoon could not be discovered within the egg.

The Modern Period.—The preceding period (1824–1874) was coincident, as we have seen, with the early history of the cell theory, but the demonstration of the unicellular character of the ovum and spermatozoon had little effect upon the problems of fertilization. The cell theory was still incomplete; the free formation of the nuclei was still held by competent naturalists, and nothing was known of the phenomena of karyokinesis. The cytological investigations of the next ten years (1874–1884) were destined to lay the foundations of the modern nuclear theory in its broad outlines. The fertilization studies of this period were mainly morphological, and while it is correct to say that they were largely dominated by the growing nuclear theory, it is also strictly true that they contributed in no small measure to its upbuilding. Though the penetration of the spermatozoon into the egg had long been suspected, it was first clearly demonstrated in this time; the origin of the egg nucleus by two successive divisions of the germinal vesicle was discovered; the origin of the sperm nucleus from the head of the spermatozoon, the sperm aster, the union of the egg nucleus and the sperm nucleus, the relation of these to the first cleavage spindle, the origin of the fertilization membrane, the ill effects of polyspermy and the theory of its prevention; and finally the doctrine of the equivalence of the egg and sperm nuclei, and the biparental character of the nuclei of sexually produced organisms, as first laid down by Van Beneden, were products of the period also. No period of cytological research seems to me of greater significance than this.

There was almost a complete cessation of investigation from 1855–1873, when the dawn of the modern period broke suddenly. In 1873 Bütschli observed in the egg of a nematode the approach and contact of the two structures, which we now know to be the germ-nuclei, immediately preceding the first cleavage of the ovum. But no interpretation was presented. In 1874 Auer-

[7] Newport's observations rose to a higher plane than those of the others, for he actually observed in the frog's egg (1) that the first plane of cleavage is in line with the point on the egg artificially impregnated, (2) that it marks the plane of symmetry of the embryo, (3) that the head of the young frog is turned towards the same point.

bach[8] described the appearance of two nuclei at opposite ends of the elongated egg of Rhabdites; these increase in size, migrate towards the center of the egg, meet, rotate through 90° and fuse together. A dicentric figure appears and cleavage follows. What is the origin of these two nuclei and the significance of their union? The fusion of two nuclei was at the time entirely without analogy. Auerbach states:

> It is natural to assume that, as for the reproduction of organisms the copulation of two individuals, or at least of two cells in some form or other is so frequently necessary, so here a similar condition is found for nuclear reproduction.

Auerbach supposes the two nuclei which appear at opposite ends of the elongated egg to have arisen freely; one of these comes from the end where the spermatozoa had penetrated, the other from the opposite end where the germinal vesicle had disappeared. The difference of the origin influences the quality of the nuclear materials arising *de novo;* fusion of the nuclei counteracts the differences thus arising; but all this would be undone if the division of the fusion nucleus followed along the plane of the union; hence the rotation through 90°.

In the next year Bütschli again observed fusion of nuclei in nematode eggs before the first cleavage. However, he did not accept Auerbach's interpretation, but he tended to regard it as a general law of nuclear formation, that first two or several small nuclei arise and subsequently fuse; this he finds to occur even in the blastomeres of the four- and eight-cell stages.

About the same time (1875) Van Beneden also observed similar phenomena in the rabbit's egg. He did not see spermatozoa enter the egg, but he found them with their heads closely applied to the surface in every unsegmented egg, and came to the conclusion that fertilization consisted essentially in fusion of the spermatic substance with the superficial layer of the vitellus. At a little later stage he found a small nucleus in the cortical layer of the egg; this he called the peripheral pronucleus; a central pronucleus appeared simultaneously. They grow, approach one another and meet in the center. Later there is only one nucleus, probably formed by the union of the two.

> As I have shown that the spermatozoa attach to the surface of the vitellus and mix with its superficial layer, it appears probable to me that the superficial pronucleus is formed, partially at least, at the expense of the spermatic substance. If, as I think, the central pronucleus is constituted of elements furnished by the egg, the first nucleus of the embryo would be the result of union of male and female elements. I put forth this latter idea simply as a hypothesis, an interpretation which may or may not be accepted.

The way was now clear for the definitive solution of the old riddle of the relation of the egg and spermatozoon, which was quickly furnished by O. Hertwig and Hermann Fol. The observations of these authors appear to have been made independently and nearly simultaneously. In 1875 Hertwig observed and described correctly the principal phenomena of fertilization in the sea-urchin egg. He did not actually see the penetration of the spermatozoon, but he observed the sperm nucleus and its aster so soon after that he had no doubt of the correct interpretation; he also observed the approach of the sperm-nucleus and the egg-nucleus to the center of the egg and their apparent fusion.

> Fertilization has been previously interpreted as a fusion of two cells, but we have now seen that the most important process involved is the fusion of the two nuclei. The union of the egg-nucleus with the sperm-nucleus is necessary to produce a nucleus endowed with living forces adequate effectively to stimulate the later developmental processes in the yolk, and to control them in many respects.

Fol's observations, made partly independently of Hertwig's and partly after the

[8] "Organologische Studien."

publication of Hertwig's first paper, supplemented Hertwig's in several important respects: (1) He observed the details of penetration of the spermatozoon with a clearness that has never been surpassed for these forms. (2) He gave the first correct account of the maturation divisions and origin of the egg-nucleus (Hertwig regarded the latter as being the persistent nucleus of the germinal vesicle). (3) He paid special attention to the origin of the fertilization membrane and founded the classic theory that it was an adaptation to prevent polyspermy. (4) He was the first one adequately to present the harmful effects of polyspermy.

The period initiated by these two men was characterized mainly by the repeated demonstration of penetration of the spermatozoon, the formation of a nucleus from the sperm head, and the fusion of this nucleus with the egg-nucleus. It was also gradually demonstrated that the egg-nucleus is genetically derived from the germinal vesicle by karyokinetic divisions. Thus the genetic continuity of the germ nuclei with nuclei of preceding cell generations was established. As yet the character of the fusion of egg and sperm nuclei had hardly been raised, for the chromosome problems and hypotheses were in a very nascent state. Flemming's discoveries concerning chromosomes and their reproduction in karyokinesis by splitting date only from 1876–1878.

All the problems of cell morphology were in a fine state of fermentation during this time, the really classic period of cell-morphology; the foundations of our present knowledge of cell-division were being laid; before the decade 1870–1880 it had been firmly established that cells arise only by division from preexisting cells; but two views of the origin of nuclei were still held, one that of free formation, according to which the nuclei of daughter cells had no genetic connection with the nucleus of the mother cell, and the other that nuclei arise by division from a preceding nucleus. Little by little as a result of numerous investigations by many investigators, both zoologists and botanists, the matter cleared up. In 1878 Flemming was able to outline the whole scheme of karyokinesis substantially as we now understand it.

The fundamental biological principle of genetic continuity was foreshadowed by the founders of the cell doctrine, and was more or less distinctly foreseen by some of their contemporaries, as in the case of Lallemand. It was yet more clearly expressed in Virchow's famous aphorism, *omnis cellula e cellula* (1856); but it could not become an established guiding principle in genetic research until the entire cell-cycle of the individual life history was worked out in broad outline, until the process of cell division was accurately ascertained and applied to the genealogy of the germ-cells, until the respective parts of ovum and spermatozoon in the origin of the new generation were understood, nor until the hoary doctrine of spontaneous generation was banished bodily from the field of biology. These were all accomplishments of that great decade in biological research, 1870–1880, for which the studies of the preceding thirty years had furnished ample preparation. The entire superstructure of modern genetic research rests upon the foundations then laid.

Professor Mark's paper on *Limax* (1881) is a point of departure between the fertilization studies of the seventies and those that were to follow. Professor Mark observed that the pronuclei come together, but do not fuse to form a first cleavage nucleus, as had been described for other animals.

The first cleavage nucleus does not have a morphological existence.

The pronuclei persist after the appearance of the cleavage centers, their membranes then gradually disappear.

In 1883 van Beneden published his now classic paper on *Ascaris*: The pronuclei do not unite, both are included in a single amphiaster; each produces two chromosomes; these divide and their halves form the daughter nuclei. In the nuclei of the first two cells there are thus equal numbers of male and female elements, and there are reasons to believe that even in these two nuclei they do not fuse; it is probable that they remain distinct in all derivative cells, including the immature eggs and spermatogonia. In the egg the chromatin is composed of two distinct parts, and

> it is legitimate to suppose that each is the equivalent of a male and a female chromosome, and that in the formation of the polar globules each throws out the male chromatin which it contains.

Van Beneden by a veritable stroke of genius thus anticipates the entire chromosome doctrine of the present time, even though certain aspects of his interpretation were not entirely fortunate: his conception of the diploid cells as hermaphrodite, for instance, and freeing of egg and sperm from the male or female elements in maturation.

With the establishment of the nuclear theory, destined soon to be elevated into the doctrine of chromosome individuality, a certain duality of cell-life was recognized in which nucleus and cytoplasm, however interdependent, were regarded as playing specific rôles. But there was no logical reason for stopping at duality, and the centrosome soon came to be recognized under van Beneden and Boveri's leadership as a third organ of cell-life reproducing itself by division. The development of this idea was due not only to studies of karyokinesis, but also to the series of fertilization studies which began with Boveri's classic papers on *Ascaris* (1887–1888). In these papers Boveri is convinced of the necessity of making "the sharpest distinction between fertilization and heredity, *i. e.*, between the question how egg and spermatozoon produce a cell capable of division, and the question how these cells come to be capable of reproducing the qualities of the parents in the offspring"; this distinction has since been generally recognized. Boveri's solution of the fertilization problem was in terms of the centrosome hypothesis: the egg is devoid of the organ of cell-division, the centrosome; capacity for division, hence the initiation of the developmental processes, is restored through the introduction of a centrosome into the egg by the spermatozoon.

This conception exerted a dominating influence on the series of fertilization studies which followed; the questions as to the origin of the sperm aster with its contained centrosome in the egg, and as to the genetic continuity of the sperm centrosome with the centrosomes of the cleavage amphiaster were energetically investigated by a series of students for the next fifteen years or more, and similar studies have continued with less energy down to the present time. Collectively these publications constitute a fairly exhaustive record of the morphology of the fertilization process in animals, a large part of which was furnished by American students.

The morphological analysis of fertilization seems now to be fairly complete; there may still be disturbances such as recent attempts to trace mitochondria back to the sperm, which seems destined to share the adverse fate of the similar attempt to trace the centrosomes to the sperm; but there is not likely to be any great modification of the existing data, which seem to me to demonstrate, effectively if not absolutely, that the sperm head contains all the substances necessary for fertilization. We have thus

attained a more or less definitive solution of the morphological relations of egg and spermatozoon in the fertilization process.

The cytologist working with chromosomes and the geneticist with Mendelian factors have traced maternal and paternal elements through the life history in a manner very satisfactory to certain classes of biologists, however repugnant to others, so that we are beginning to see how certain strands of the web of life cross the gap of successive generations. It remains for the biology of the future to elucidate the chemical foundations of chromosome behavior and to identify the Mendelian factors in these chemical foundations.

The problems of the immediate reaction of the reproductive elements and the physiology of fertilization are not touched by this morphological analysis, though they had been present in the minds of investigators from the beginning. The experimental investigation of these problems dates from Spallanzani, as we have seen, but they did not become dominant until the morphological problems of fertilization were in an advanced stage of solution. They constitute, however, the more immediate problems of fertilization, considered in a restricted sense.

We have had two lines of attack since the studies of O. and R. Hertwig published in 1887 really initiated the modern period in the physiology of fertilization. The one is a direct experimental analysis of the fertilization process itself; the other is the attempt to imitate the action of the spermatozoon by chemical and physical agencies, in short the studies on artificial parthenogenesis. I shall not attempt to deal with the latter, which constitute one of the most interesting and suggestive chapters in modern biology, beyond attempting to define their relation to the problems of fertilization proper.

It was soon found in the course of studies on artificial parthenogenesis that no single physical or chemical agency suffices to initiate development in all eggs, and that when the various agencies effective in all the successful experiments are assembled they constitute a fairly complete list of agencies to which protoplasm in general is irritable. The idea then arose that the common factor must be the effective one, but no common factor has been found, or can be found, in the agents themselves; the only common factors are in the reproductive cells. This leaves the method of parthenogenesis in the same position as the method of analysis, that is in the position of determining what are the changes in the egg itself that initiate development, and what is the nature of their dependency upon the external agent or spermatozoon? The answer to these questions can not proceed exclusively from parthenogenetic studies, though to the extent that the same questions are involved parthenogenesis and fertilization studies must furnish the same answer. But there are obviously fundamental problems of fertilization that can not be touched by methods of artificial parthenogenesis.

The conditions to be fulfilled in fertilization involve not only penetration of the spermatozoon, or some part of it, into the egg, but also reaction between the two, which is evidenced by the behavior of both partners; for it is possible for a spermatozoon to penetrate an egg and no reaction to be evidenced in the behavior of either the egg or sperm; as when immature eggs are penetrated by mature spermatozoa. We may therefore speak of a *fertilization reaction* when the behavior of both partners indicates that the process is proceeding normally. Fertilization has its quantitative aspect, and the reaction may be complete or exhibit varying degrees of incomplete-

ness. For a normal fertilization reaction certain internal conditions of the partners and certain external conditions of the medium must be realized. The study of the external conditions throws light upon the reaction, because the nature of the internal conditions may be inferred from the necessary, from the inhibiting, and from the favoring conditions of the medium.

External Factors.—The fertilization reaction like all biological reactions requires certain conditions of the environment, such as definite range of temperature and chemical composition of the medium. In the first place, if these are exceeded in either direction so far as to injure the cells the fertilization reaction either does not take place, or it is rendered abnormal. The cause of the failure, or the abnormality, in such cases lies in some change of the internal composition of one or the other of the germ-cells. The classic experiments of this kind are those of Oskar and Richard Hertwig published in 1887. These investigators studied the effects of high temperature, various injurious chemical reagents and of mechanical shock on the germ-cells separately before fertilization, and on the process of fertilization itself at various stages. Many exceedingly interesting observations were made, and problems were raised that were not then ripe for solution. Other experiments of a similar kind have since been made, but their consideration properly belongs to the problems of the internal factors, for the phenomena observed depend upon internal changes of the germ-cells.

In the second place there may be modifications of the medium which do not directly injure the germ-cells, but which inhibit or favor the fertilization reaction. Examples of inhibiting phenomena are found in Professor Loeb's studies of the relations of ions to the fertilization reaction, or my own on the inhibiting action of blood or tissue secretions of the same species on fertilization. The most striking example of conditions favoring fertilization is the action of alkalis in enabling interclass hybridization, discovered by Jacques Loeb. Such experiments furnish important data for the analysis of the reaction, but it is obvious that their interpretation must depend upon internal conditions of the fertilization reaction.

In the third place the membranes of the egg and of the spermatozoon must influence the occurrence, rate and extent of the fertilization reaction according to the degree of their permeability to the substances concerned; the egg-membrane is of course more especially concerned; its rôle in the occurrence of parthenogenesis has been studied especially by R. S. Lillie; and I have found in the case of the starfish egg that a resistant egg-membrane may entirely block the fertilization reaction, though the block may be removed by agents that render the membrane more permeable.

The internal conditions of the fertilization reaction may be grouped under two heads: (1) Maturity of the germ-cells; (2) specificity of the reaction.

1. *Maturity.*—Concerning conditions of maturity of the spermatozoon but little definite is known, except that it will not fertilize before its differentiation is complete. Whether the cause of this lies entirely in deficient motility, or partly also in incomplete chemical differentiation, we do not know; though there are some reasons for thinking that the latter factor may be involved. In the case of the ovum our knowledge is in a much more advanced stage. We know that the fertilizable condition, which represents the final maturity of the ovum, arises rather suddenly, usually lasts but a short time, and is lost as an immediate consequence of the fertilization reaction. (*a*)

That the fertilizable condition arises suddenly has been shown especially by the work of Délage on the starfish egg and of Wilson on the egg of *Cerebratulus*. Their experiments on merogony showed that parts of the full-grown ovum taken prior to the rupture of the germinal vesicle are incapable of fertilization; but, soon after the rupture of the germinal vesicle, parts, whether nucleated or not, readily fertilize. Hertwig's observations (1877) also showed a complete failure of the fertilization reaction in primary ovocytes of the sea-urchin before rupture of the germinal vesicle, even when spermatozoa penetrated. I have observed the same thing in *Chætopterus*.

(*b*) Eggs of *Platynereis* lose their capacity for fertilization almost immediately after coming into sea water, even though spermatozoa may penetrate (Just); eggs of the frog become unfertilizable after half an hour in water (Spallanzani); eggs of the wall-eyed pike completely lose their fertilizability after ten minutes in water (Reighard). Usually fertilization capacity begins to fall off in one or two hours after eggs are laid in most marine animals, though in some, as in the sea-urchin, it may persist much longer.

(*c*) Once fertilized eggs do not fertilize again, nor do parts of such eggs freed of the fertilization membrane. It should therefore be impossible to superimpose parthenogenesis and fertilization; and the studies of Mr. C. R. Moore, one of my students (not yet published), show this to be the case. Apparent superposition appears in all cases to be due to incomplete reactions, which cease and may be subsequently resumed. The fertilization reaction appears to be irreversible; and the appearance of reversal in parthenogenesis may be referred, like superposition of fertilization on parthenogenesis, to incompleteness of the initial reaction.

Specificity is an outstanding feature of the fertilization reaction, the significance of which is not weakened by any hybridization experiments. We need not stop to define the limits nor the consequences of hybridization in order to justify the assertion that no theory of fertilization which fails to include the factor of specificity as one of the prime elements can be true.

The fundamental character of specificity is illuminated by the phenomena of self-sterility; in species where this occurs the eggs and sperm of the same individual are sterile *inter se*, though fertile with those of all other individuals. This has led some botanists to the conception of individual stuffs; but Correns's experimental analysis led him to the conclusion that the specific factor is not an individual stuff, but a definite combination of stuffs for each individual. The combination arises always with the individual, and disappears with it. An extension of the principle of self-sterility is found in that mutant of fruit flies discovered by Morgan in which the males and females are fertile with other mutants, but sterile *inter se*. The only biological parallel of such phenomena is found in the individual blood composition revealed by serological studies. That there is a common factor in species and individual specificity studies no one who has studied both sets of phenomena can doubt.

A consistent theory of fertilization must take account of all these phenomena, not only the internal factors of maturity of germ-cells and the specificity of their reactions, but also the external factors that favor or inhibit the reaction. I have attempted to show in a series of papers that the fertilizable condition of the egg depends upon the presence of a specific substance which is produced at the time of rupture of the germinal vesicle and which disappears completely after fertilization.

If this substance be present in the egg in adequate amount, the egg can be fertilized, otherwise not. It may be obtained in solution in the sea-water and recognized by its capacity for agglutinating sperm suspensions of the same species, in some cases at least. If it is thus possible to associate the fertilizable condition of the ovum with a definite substance, we have a base from which an analysis of fertilization can be made.

If the existence of such a substance be admitted, it must operate either by activating some substance in the spermatozoon, which is to be regarded as the effective agent in subsequent changes, or we must regard it as the effective agent which is transformed from an inactive to an active state by some substance in the spermatozoon. If we take the first alternative, we have no explanation of parthenogenesis, whereas if we regard the egg substance as the active agent, the explanation of parthenogenesis proceeds along the same lines as that of fertilization. Moreover, I have been able to show by an analysis of the phenomenon of blood inhibition of fertilization, that the first point of view is untenable.

This substance may therefore be called the fertilizing substance, or fertilizin. By its reaction it is shown to be a colloidal substance, not giving the usual protein tests, and exhibiting some of the properties of a ferment as shown by Richards and Woodward. Fertilization would thus be a three-body reaction between the sperm-receptors, fertilizin and egg-receptors linked in line; and it is possible to show that inhibiting agencies may operate at the various linkages of such a reaction. In its reaction with the sperm the fertilizin of different species exhibits a certain degree of specificity, which should be more fully studied, but which has been partly explored by Jacques Loeb and myself.

This form of hypothesis takes into account the internal factors both of maturity of the germ-cells and their specificity; it is also adapted to explain the environmental conditions of fertilization extremely well; and it is consistent with the results of parthenogenesis, and the known relations of parthenogenesis and fertilization to the permeable or impermeable conditions of the egg-membrane.

I believe that I speak for all naturalists when I express my admiration for the advances in the conception of the cell due to the labors of many physiologists. But those of us who deal with the more complex phenomena of cell-life as shown in fertilization, in the behavior of chromosomes, and in the phenomena of heredity, feel that no advance in our comprehension of the cell-membrane, of the relation of cell-activity to electrolytes, nor of the chemical analysis of triturated cells, will lead to a fundamental comprehension of these phenomena. There is a great gap in our knowledge of cellular physiology, the significance of which is not generally appreciated. We know nothing except what our microscopes show us, of the reactions of the colloidal substances of the living cells; and all hope of a physico-chemical analysis of cell activities is premature until the gap is filled in.

The main physiological problems of fertilization are still before us; all the work up to the present has merely prepared the way for their solution. Fertilization is the knot in the webs of successive generations which must be untied before we can trace the strands from generation to generation. The task bespeaks all that we know, or may hope to know, of cellular physiology. As in all times of the history of the subject our vision is limited by our general biological conceptions, and the problem will move forward as our general knowledge of

cell-life progresses; and it will aid in its turn in the general advance.

We have followed the history of the problem of fertilization from the metaphysical stage through the morphological stage into the physiological stage, and within sight of the physico-chemical stage. Possibly the results seem slight as a record of 265 years of continuous study of a single biological problem. But we read the history of science very superficially indeed if we fail to realize the constant interdependence of all scientific thought. There has probably been no time in the history of our particular subject when a greater amount of work on its problems would have caused a much more rapid advance. Scientific discovery is a truly epigenetic process in which the germs of thought develop in the total environment of knowledge. Investigation of particular problems can not be accelerated beyond well-defined limits; progress in each depends on the movement of the whole of science.

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THE WORK AND OPPORTUNITIES OF A DEPARTMENT OF RESEARCH MEDICINE IN THE UNIVERSITY[1]

IF we analyze the discussions of present-day problems of medical education we find that an important if not the ultimate object of any particular plan is greater opportunity for research. This we find in the argument of those who support the plan of the full-time teacher, the plan that the university should own its hospital or control one by close affiliation, and also it is evident in all plans for greater endowment. Increased facilities for research and an augmentation of the number of men engaged in research, or combining research with teaching, would ensure, it is contended, not only important progress in the science of medicine, but also a higher development of both medical teaching and medical practise. To what extent this increased interest in research is due to the popularization of medicine through the practical application of discoveries in the fields of bacteriology and protozoology and to what extent to a dissatisfaction with time-honored methods in medical education, it is difficult to say. Both undoubtedly have had some influence but they alone can not explain the rapidly increasing number of experiments in medical education which have for their avowed object the stimulation of medical research in school and hospital. As the most important of such experiments I need only remind you of the so-called "full time" scheme at Johns Hopkins Medical School fostered by the General Education Board, the affiliation between Columbia University and the Presbyterian Hospital of New York City, the development in Chicago of the Otho S. A. Sprague Institute which, without buildings of its own, utilizes for purposes of research in medicine the already existing laboratories and hospitals of that city, and more recently in San Francisco in connection with the University of California, the establishment of a well-endowed department for general research in medicine. On a smaller scale we find the establishment, definitely within the university, of separate departments for the investigation of tropical diseases, of cancer, of tuberculosis, of chronic diseases, or of departments devoted less specifically to experimental medicine, comparative pathology, comparative physiology and the like. As all such foundations must be considered for a time at

[1] Address of the vice-president and chairman of Section of Physiology and Experimental Medicine of the American Association for the Advancement of Science, Columbus, January 1, 1916.

least, as experiments in medical education and research, and as the increase of endowment for the better type of medical effort will naturally depend to some extent upon the efforts, successful or otherwise, of the foundations already in existence, it seems advisable that those responsible for the expenditure of research funds should from time to time report upon their efforts —both useful and futile—in order to guide those giving or receiving funds for investigation in medicine. It is for this reason that I present to you, to-day, the experience of a small university research department for the management of which I have been responsible during the past five years. It is not always comfortable to talk about one's own work and efforts and I realize that I may be criticized for bringing myself and my department into the limelight in this way and particularly on this occasion, but I am satisfied from the number of inquiries I receive about the plan and scope of our work that there is a general desire on the part not only of medical faculties and university trustees, but also of individuals who wish to aid and foster research in medicine, to know more about the experience of foundations already established. For this reason, despite possible criticism, I present the general facts concerning some of the phases of the work of the John Herr Musser Department of Research Medicine of the University of Pennsylvania during the past five years.[2]

This department was endowed in 1909 under a deed of gift which provided for the establishment of a chair of research medicine in a department of similar name.[3] Some of the important conditions contained in this deed of gift which have necessarily determined the work of the department are as follows:

1. That the department concern itself especially with the study of chronic diseases[4] by laboratory methods and with the aid when necessary of the wards of the university hospital.

2. That the professor of research medicine devote his entire time to the conduct of the department, his duties as a teacher being limited to not less than fifteen lectures or demonstrations on the work of the department to be given to students of medicine of the University of Pennsylvania.

3. That the facilities of the department be open to members of other departments of the university and to such students and practitioners as might be considered capable of conducting research work.

4. That the income of the endowment be applicable to the purposes of the department of research medicine and in and about no other department of the University of Pennsylvania or otherwise.

In brief the conditions of the endowment established a department for the study of chronic diseases, reduced the teaching duties of the staff to a minimum and provided that opportunities for research should be given to those desiring such work and that the income could not be used to eke out the expenses of existing departments. The qualifying statements, however, in regard to each of these conditions allowed considerable latitude of interpretation, both as to scope of work and relations to other departments. The work of the department, as determined by the various conditions stated, may be considered under the following heads:

[2] September 1, 1910, to August 31, 1915.

[3] In 1912 after the death of John Herr Musser, professor of clinical medicine in the university, and at the request of the original donor, the name of the department was changed to The John Herr Musser Department of Research Medicine.

[4] Some diseases were specifically mentioned, as, for example, gout, rheumatism and nephritis.

1. Investigation of the problems of certain chronic diseases.

2. Cooperative efforts with other departments, particularly the department of medicine.

3. Special elective courses of instruction for medical students, and

4. Opportunities for research offered to physicians and others.

These four lines of effort have been the chief object of the department and upon the success of these must rest opinion concerning the value of such a department to the medical school or the community.

1. INVESTIGATION

From the point of view of the investigator the field of the chronic diseases is the most difficult of approach in the entire territory of medicine and it is for this reason that our exact knowledge of these diseases progresses so slowly. The very slight knowledge we have concerning their etiology, the insidious nature of their onset, their slow progress, the frequent involvement of several organs in a general degenerative process, and the difficulty of reproducing pure types of chronic lesions experimentally, render impossible the brilliant achievements which have characterized the attack on the acute infectious diseases by the methods of bacteriology and immunology. Progress must depend on the slower methods of physiology and chemistry as used in experimental and clinical studies. The immediate problem in a given disease is to understand the gradual and progressive changes in physiology which a particular type of organic lesion produces rather than to discover its exact etiology. Naturally etiology and of course therapeusis, looking to amelioration of a chronic diseased condition, are the ultimate objects of researches in this field, but at present the best form of attack seems to be that designed to explain pathological physiology and especially the physiology or chemistry of the characteristic crises and complications, as, for example, the edema, uremia and hypertension of nephritis, the acidosis and coma of diabetes, the exacerbations of gout and so forth. The investigation of individuals, the subjects of chronic disease, by means of metabolism studies, functional tests and instruments of precision, as those applied to the cardio-vascular system, must constitute an important phase of work in this field. This must, necessarily, be supplemented by experiments on animals which have for their object the reproduction of lesions chronic in nature which may then be studied by the methods of physiology and chemistry, or, if this is not always possible, by the reproduction of isolated phenomena, or analogous symptoms or complications. Chronic disease and its phenomena can not always be imitated perfectly by experiment, but the imperfect experiment may nevertheless throw some light on the phenomena of a particular disease. Finally, a department devoted to this field of disease must be prepared to test out new functional and other tests and to apply immediately the discoveries of physics, physiology and chemistry to both the experimental and clinical study of chronic disease.

Whether or not this plan of approaching the study of the chronic diseases is the best that could be conceived, it remains the plan adopted by the department under consideration. The principal lines of investigation which have been followed during the past five years have been those concerning (1) diseases of the kidney and (2) the spleen in relation to anemia and hemolytic jaundice. The first of these studies was undertaken largely on account of the great importance of nephritis as the common dis-

ease of advancing life and so frequently responsible for the final exitus and partly because it was one of the diseases for the study of which the department was founded.[5] The studies of the spleen were inaugurated on account of the almost total lack of knowledge concerning the function of this organ, the apparent relation it has to certain hemolytic anemias, and the improvement in the latter which follows the removal of the spleen. An analysis of the publications of the department during the five years of its existence shows that nineteen are more or less directly concerned with the study of diseases of the kidney and twenty-four equally so with problems concerning the spleen. Of these about one eighth are comprehensive metabolic or other studies of patients—while the larger number were based on experimental observations on animals. Other investigations concerned themselves with anaphylactic shock, the depressor substance of various tissues and fluids, the coagulation of the blood, the cerebrospinal fluid, the utilization of parenterally introduced serum, diseases of the heart, and the toxemias of pregnancy. As to the ultimate value of this work, we naturally offer no opinion. This brief summary is presented merely to indicate the general character of the research work of the department.

Another group of fourteen publications presented the results of the study of various new functional tests and methods of diagnosis. These include such subjects as the phthalein test for kidney function, Abderhalden's test for pregnancy, Folin's methods for non-protein nitrogen in the blood, the tetrachlorphthalein test for liver function, a critical study of Crehore's micrograph for recording heart sounds, and the technique of the Eck fistula operation with regard to its possible application to human surgery.

[5] The deed of gift referred specifically to diseases of the kidney.

This testing of new methods, while not to be dignified as original investigation, we have considered nevertheless to be an important part of our work. It is well known that the busy hospital laboratory can not take up at once every new diagnostic aid that is announced. If the new method involves a simple technique and is easy of application it may gain wide use at once; but if further observation and experiment is necessary and especially if it demands animal experimentation, or new laboratory equipment, the average hospital waits until further trial in the laboratories of the medical sciences demonstrates its value and thus finally forces its practical application. We have felt that we are justified in giving a part of our time and resources to work of this character in order to reduce the waiting period which usually follows an announcement of a new procedure, applicable to the study of chronic disease. Incidentally the educational value to the department staff is a matter of no small importance, for its members at once become familiar with the technique of the new procedure, and such as engage also in hospital work or clinical teaching can at once put the method into practical use or instruct medical students and others concerning its value.

2. Cooperation with other departments

It is not the usual cooperation between departments that I wish to describe at this time. Every department desires from time to time the assistance, in connection with the solution of its problems, of the skill or equipment of other departments and this has naturally been our experience in connection with the widely varying methods of studying chronic diseases. We have found it necessary to call on the department of

surgical research for the aid of its special skill in peculiarly difficult operative procedures, on the department of pathology for cooperation in problems demanding the methods of immunology and frequently on the department of physiological chemistry for cooperative assistance in technical procedure. On the other hand, we have given assistance in the solution of their problems to the departments of medicine, neurology, surgery and obstetrics. In the case of each of the departments named the cooperation has been successful inasmuch as the combined efforts at investigation have resulted in the publication of material of benefit to the departments interested. It has been our experience, moreover, that the presence of departments for research[6] stimulates among the workers in various other branches much discussion of borderline problems, with the result that the presence of one or more groups of men, giving their time entirely to research, encourages doubtful or difficult ventures in investigation that the teacher with his many duties and limited time for research would not attempt without the assistance of a department interested in research only. This is particularly true of the average busy clinical teacher whose hazy views on some theory or problem occasionally suggest a workable basis for orientative experimentation. With such views, in that they do not always concretely set the problem, the workers in the fundamental sciences of medicine are usually somewhat impatient. When, however, a department for the general investigation of disease exists, it can afford, in the hope of securing better cooperation with the clinical side of medicine, to sift and analyze such suggestions, and if a possibility of profitable investigation, or of definitely settling a moot point, is seen, it is justified in utilizing a certain amount of its time and funds in thus assisting the clinical department. And if in so doing it can persuade members of these departments to actively cooperate in the solution of the problems under consideration, and thus stimulate the spirit of exact investigation it is doing as much, if not more, for research and the development of clinical medicine than it would by restricting its efforts to the hard and fast lines of fundamental problems.

This cooperative work with other departments, valuable as it is, is, however, as a rule more or less incidental and without definite responsibility on the part of either party concerned. It does not represent sustained cooperative effort, but rather the coming together of two departments when mutual need arises. We have, however, with one department, that of the theory and practice of medicine, developed a community of interest and definitely cooperative effort which we regard as a most important experiment in medical education. Three years ago an agreement was entered into with the professor of medicine (Dr. Alfred Stengel), and largely at his suggestion, by which it was provided that the two associates most intimately concerned with him in the teaching of students and the care of patients in the university hospital, should give half their time to investigation in the department of research medicine. In other words, two men intimately connected with the fundamental instruction in clinical medicine were to devote their mornings to the teaching of students and the care of patients and their afternoons to fundamental research in a laboratory independent of the hospital. In the absence of the "full time" plan in the clinical departments of the school this seemed an experiment with "full time"

[6] This refers not only to the department under discussion, but as well to the department of surgical research under the direction of Dr. J. E. Sweet.

assistants well worth trying. It should be stated that this arrangement was not due to a lack of opportunity for research laboratory work in the hospital. The university hospital has two spacious and well-equipped laboratories, one in the hospital proper for the usual routine examinations and the other, The William Pepper Laboratory of Clinical Medicine, in a separate building, with an independent endowment and a large staff, engaged in the various research problems arising in connection with clinical observation in the wards. The cooperation with the department of research medicine, which has its laboratory in the medical school building, was for the purpose of enlarging the opportunities of the department of medicine and the department of research medicine by bringing the latter into closer contact with the problems of the wards, and allowing workers in the former department the utilization of the methods of the fundamental sciences in the solution of their problems and the broadening of their training. During the three years this arrangement has been in operation the results have been most gratifying and the arrangement has been of advantage to both departments. The research work of the two men concerned has been in part the study of patients under their care by the detailed methods of metabolic investigation and the use of functional tests, in part experimental work on animals in connection with fundamental problems, and in part the careful testing out of new methods of possible clinical application. Fully a third of the researches of the department completed during the past three years have been published under their names, either as independent authors or in collaboration with other members of the staff. On the side of productive research this is for them a most creditable showing; on the other side, that of their development as clinical teachers, there is abundant evidence that they have found this experience of great value. But for the university there is also something gained. Men desiring to devote themselves to a career as teachers of medicine can by this cooperation gain the proper balance between teaching, research and routine ward work without one phase suffering at the expense of the other. They can keep at all times in touch with each field of activity, and when the time comes that a man is overwhelmed by the lure of the clinic and finds that he must curtail the time given to fundamental research, and feels obliged to limit his investigations to the hospital laboratory, the university has the assurance that his fundamental laboratory training has been satisfactory. On the other hand, it is to be hoped that such a system will occasionally stimulate and hold the rarer type of clinical mind which finds its greatest satisfaction in the solution of the more difficult fundamental problems of medicine rather than in the practical applications of the clinical laboratory. Clinical medicine needs most men who would rather blaze a new path than clear the trail of those who have gone before. It is only through conscientious effort in the fundamental investigation of disease that such can be developed. To assist in developing men of this type is a function of the research laboratory in the university but, falling short of this, it can do what is perhaps only second in importance—cultivate proper ideals in its younger clinical teachers.

3. Elective Courses

The requirement, in the deed of gift, that the department should engage in teaching to the extent of not less than fifteen lectures or demonstrations in each year has been met by offering special elective courses, dealing with the experimental side of medi-

cine, and largely demonstrative in nature. It was the intent of the founder of the department, apparently, that the lectures or demonstrations offered should be given to an entire class. This plan was not carried out, partly because it would duplicate work already given in a systematic way by other departments and partly because it seemed unwise to add another set of didactic lectures to an already overcrowded curriculum. An alternate plan was therefore adopted of a series of elective demonstrations so arranged as to supplement the didactic and clinical teaching in other departments and to illustrate by experimental procedures, in a more or less intensive way, the physiology, chemistry and pathology of various organs or groups of organs. With a desire to determine the best system for such teaching, and also to find out what type of work and instruction appealed most to the student of medicine, the subject matter and method of this instruction has been changed from year to year. As our efforts in this regard are of some interest they will be briefly summarized. During the first year a comprehensive series of demonstrations in experimental pathology was given for the benefit of the class (second year) in pathology. This was offered twice a week during a period of fourteen weeks, half the class attending, if they desired, one demonstration each week. The subjects covered were degeneration and necrosis, inflammation and repair, blood destruction and jaundice, thrombosis embolism and infarction, experimental lesions of the heart, lungs, stomach, intestines, liver, pancreas, and kidney, the problems of infection and immunity, of shock and hemorrhage and the physiology of the ductless glands.[7] As far as possible the gross and microscopic lesions of disease in man were correlated with experimental lesions and the relations to clinical medicine emphasized. Physiological methods of graphic registration were employed whenever possible; changes in the urine and other secretions demonstrated; and the methods of chemical examination shown. Furthermore, in the exercises on the heart and lungs the work was done in cooperation with the instructor in physical diagnosis.

In the following three years this course was not offered in its entirety. Thus one year a group of ten students (fourth-year class) studied with great thoroughness the normal and pathological physiology of the cardio-vascular system, and in the following year the same course was given as a demonstration course and in less detail to the entire third-year class, divided into sections for this purpose. In still another year the problems of hepatic and renal and pancreatic disease were taken up by small groups of men from the fourth-year class.

At the end of four years of such concentrated experimental work we were impressed by the fact that although the student had gained a better insight into the problems of pathological physiology and therefore of disease processes, the time given to the various experimental procedures left little or no time, in our short two-hour periods, for the discussion of theories and the relation of new facts to old conceptions. And even with the constant presence at all these exercises of the two clinical associates, to whom I have previously referred, whose interest led them to emphasize matters of clinical importance, we felt that a thorough correlation of experimental procedure and clinical observation was not always attained. In the fifth year, therefore, we tried the experiment of a seminar for the discussion of the various problems peculiar to certain groups of disease. In this sem-

[7] Pearce, R. M., "The Teaching of Experimental Pathology and Pathological Physiology to Large Classes," *J. H. H. Bull.*, 1911, XXII., 1.

inar were united the chairs of medicine (Dr. Alfred Stengel), pharmacology (Dr. A. N. Richards), physiological chemistry (Dr. A. E. Taylor) and research medicine with their respective staffs and the seminar was thrown open to students of the fourth-year class as an elective. The medical clinic room of the hospital was used for these exercises in order that lantern demonstrations and the exhibition of patients might be possible. All other demonstrations were barred in order to have plenty of time for discussion. The first trimester started auspiciously with the discussion of diabetes and a sufficient number of students in attendance to guarantee, apparently, the success of the venture. But no student elected the course for the second and third trimesters devoted respectively to renal disease and diseases of the ductless glands. In brief, from the point of view of interesting the medical student, the seminar was a dismal failure. For the teaching and research staffs represented, the exchange of views was very profitable and despite the absence of students the seminar was continued through the year. It is perhaps needless to say that the students lost interest because of the many detailed discussions of opposing and oftentimes irreconcilable views which led the disputants away from the fundamental basis of accepted facts. Perhaps also the fact that the students could take no part in the exercises, except to ask questions, had something to do with their lack of interest.

We have, therefore, abandoned the seminar as an aid to discussion—perhaps it smacks too much of the didactic lecture, anyway—and have this year returned to the plan of offering to small groups of men three short, elective experimental courses dealing respectively with the cardio-vascular system, the liver and bile passages and the chronic degenerative diseases.

I have gone into these experiments in elective teaching in some detail because not only do I feel it is a very important part of our work, but also because I am convinced that in every school the men of the fourth year should have some means of reviewing in a practical way the knowledge they have obtained of one or more of the systems of the body. No better method exists, I believe, than the experimental course with its demonstrations of pathological physiology and chemistry, the necessary review of physiology, pathology and pharmacology and the obvious applications to clinical medicine. In short, such courses help to bring physiology into relation with morphology and to fill the gap which exists between pathological anatomy, on the one hand, and the clinic on the other. It is perhaps peculiarly the function of a university research laboratory[8] to develop such courses, and I consider our efforts in this direction to be a very important part of our work during the past five years.

4. Research by Students and Practitioners

The fourth of the important objects of the department has been to furnish opportunity for investigation, as stated in the original deed of gift, "to properly trained students and practitioners" of medicine. In this, in so far as the student is concerned, we have not been successful. This is, however, not the fault of the department, which has always been ready to encourage research by the medical student; nor, on the other hand, is it the fault of the students, many of whom have attempted to find time for a moderate amount of research work.

[8] In connection with our practical working out of these courses no claim for originality is implied. The general plan here outlined is largely that used several years ago in the department of pathology of the Johns Hopkins School by Professor W. G. MacCallum.

The failure is due to the demands of an overcrowded inflexible curriculum and an inadequate elective system. During only one trimester, a period of a little more than ten weeks, in the fourth year, has the undergraduate any freedom in the choice of work and in this period the total of hours that may be given to purely elective work is so small that sustained investigative work is impossible. A few enthusiastic students have occasionally attempted to utilize Saturday afternoons and odd hours during the week, but with, as was to be expected, no very definite results. As a matter of fact, during the five years the department has been in existence only one piece of work by students, deserving of publication, has been completed, and this represented student labors during a summer vacation period. The summer climate of Philadelphia, however, is not conducive to close laboratory work and students desiring medical work in the summer are inclined to seek fields demanding less arduous efforts than those of the research laboratory.

Our experience, then, has demonstrated the futility, in the absence of a liberal elective system, of attempting to interest students in independent investigation. Our present attitude is to recommend to those seeking such that they take the special elective courses which we have already described. These at least give a first-hand knowledge of experimental methods and some idea of the problems of medicine, and this is about all that can be accomplished in the small amount of time our students have for elective work.

The situation in regard to the practitioner of medicine is quite different. During the five-year period under analysis, about fifteen practitioners have entered the department for the purpose of carrying on definite investigative work, and of these, nine, either working alone or in collaboration with members of the regular staff, carried to completion a total of fifteen researches. In part these researches had a close relation to clinical methods and problems, but in a number of instances they were fundamental investigations in experimental pathology. All these workers have expressed the liveliest satisfaction at the opportunity afforded them and in many instances have continued an interest in the research side of medicine. These were, for the most part, younger men, with their hospital interneship back of them, who were starting the practise of medicine and wished to divide their spare time between dispensary and research work, or, as in some instances, to devote it entirely to investigative work. We have felt that a department for research in medicine could use its resources in no better way than to encourage such aspirations and for this reason every effort has been made to guarantee to these men accomplishment without undue loss of time or effort in petty routine work. Naturally such men do not remain for any great length of time[9] because of the demands of practise, hospital, dispensary and other clinical work, but if they carry into the latter the spirit of the investigator and utilize the hospital laboratory in the study of clinical problems, the time and effort given in their behalf by the research laboratory is not entirely lost. If the progress of medicine depends, as we like to think it does, upon the spirit of investigation, young men entering upon the practise of medicine should devote a part of the post-hospital period to methods of exact observation and experiment, and if a university possesses a department of research in medicine, one of its first duties

[9] One man remained with us four years and another two years: the others averaged about six months each.

is to offer to recent graduates who have enough time at their disposal, facilities for such work. For its ultimate success, however, such a policy must have the sympathy of the clinical teachers. If the latter discourage the spirit of research, and do not themselves engage in investigation, and especially if they urge that the younger men enter immediately, and to the full extent of their time, into distinctly clinical work, the research department need not expect many voluntary workers, and might as well plan its activities on the basis of its permanent full-time staff. If, on the other hand, the clinical atmosphere is stimulating and progressive, the research laboratory is perhaps doing its greatest good in providing for the men who wish to combine clinical observation with experimentation in the laboratory.

In this brief discussion of the main phases of the development of the department under discussion I have thus far omitted all reference to the questions which are frequently asked concerning such a department. Is not a department in the university for research only an anomaly? Should not the teacher be an investigator and the investigator a teacher? Would it not be better instead of a department for research only, to divide an endowment for research among existing teaching departments? These and many similar questions have often been put to me during the past five years and I have always answered that teaching and investigation, in my opinion, should go hand in hand, and that if adequate endowment could be procured to place teaching and research in every department of the medical school on a basis which would ensure adequate results, there would be no need for a separate department of research. Unfortunately no school possesses such endowment and probably will not for some time to come. In the meantime, it is evident that there is a tendency on the part of those wishing to advance the knowledge of certain diseases, or groups of disease, to offer to universities funds for the study of such. For the most part these funds do not represent large endowments, but sums which average two or three hundred thousand dollars and are for this reason given to institutions, as universities, which already have the buildings in which such concrete department may be housed, thus obviating the necessity of spending the income or a part of the principal for a new building. Likewise it is usually stipulated that the money is to be used for research and not for teaching. The object of this provision naturally is to prevent the diversion of funds to purposes other than those for which the gift was intended. Such gifts obviously intended for the more or less concentrated study of one disease or a group of disease can do little more than support a chair with one or two assistants or fellows, if much is to be left for diener services and expenses of equipment and maintenance. Its work at the most must be modest in comparison with our larger well-endowed non-university research institutions. But despite these restrictions as to scope, purpose and field no university can refuse a gift which means an added effort for the advancement of medicine. Gifts similar in character, and, it is to be hoped, larger in amount, may come to any medical school prepared to take up such work, and their trustees can not refuse them on the ground that they do not believe in departments for research only and prefer to wait for endowment which may be used to combine research with teaching. They will in the future, as in the past, accept them, in the hope that a research department will find not only a field for independent work, but as well many opportunities to cooperate with and to aid and complement other de-

partments interested primarily in teaching.

To emphasize some of these possibilities and opportunities, as exemplified in our department at Pennsylvania during the last five years, in the hope that our experience may be of benefit to other universities, is the principal object of this exposition.

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SCIENTIFIC NOTES AND NEWS

DR. EUGENE WOLDEMAR HILGARD, professor of agriculture in the University of California from 1875 until his retirement in 1904, distinguished for his contributions to agricultural chemistry and geology, died on January 8, in his eighty-fourth year.

THE American Association for the Advancement of Science held a special meeting in Washington on January 3 and 4, in honor of the Pan-American Congress. On the evening of January 3 Dr. R. S. Woodward, president of the Carnegie Institution, presided, and Dr. W. W. Campbell, president of the American Association, delivered an illustrated address on the "Evolution of the Stars." On January 4 two sessions were held at the new National Museum when programs were presented relating mainly to the natural history of South America.

THE Italian government has placed the zoological station at Naples under the control of a royal commission, of which F. Sav. Monticelli, professor of zoology in the University of Naples, is president. The commission announces that it will furnish means to continue the work of the station, and engagements entered into in regard to tables for research.

DR. REID HUNT, of the Harvard Medical School, has been elected president of the American Society for Pharmacology and Experimental Therapeutics.

DR. SAMUEL G. DIXON has been elected president of the Academy of Natural Sciences, Philadelphia, for the twenty-first time and executive curator for the twenty-fifth time.

ROBERT BRADFORD MARSHALL, chief geographer of the United States Geological Survey, has been appointed superintendent of national parks.

DR. JOHN S. BILLINGS, JR., has been appointed deputy health commissioner of New York.

MR. BURIAN, the Austrian premier, is reported to have suggested through a neutral ambassador that Dr. Robert Bárány, the Viennese aurist and winner of the Nobel prize in medicine, now a prisoner in Russia, be exchanged for a Russian prisoner held in Austria.

DR. ALFRED IRVING LUDLOW, professor of surgery and surgical pathology, Seoul Medical College, Korea, will sail for the Orient to resume his duties on January 8, 1916.

PROFESSOR GEORGE NEIL STEWART, director of the H. K. Cushing Laboratory of Experimental Medicine, Western Reserve University, has returned from abroad.

THE magnetic survey vessel, the *Carnegie*, at present under the command of J. P. Ault, of the Department of Terrestrial Magnetism, arrived at Port Lyttelton, New Zealand, on November 3, after a successful continuous trip of ninety days from Dutch Harbor, Alaska. Leaving Port Lyttelton on December 5, the *Carnegie* is now engaged on the accomplishment of the circumnavigation of the region between the parallels 50° and 60° south, where almost no magnetic data have been secured during the past 75 years.

A BIOLOGICAL expedition to the island of Santo Domingo will be undertaken next fall by Professor J. G. Needham, of the department of entomology in the college of agriculture, Cornell University. He will be accompanied by his son, J. T. Needham, '18, and by Ludlow Griscom and K. P. Schmidt, both assistants in his department.

PROFESSOR C. P. BERKEY, of the department of geology of Columbia University, has just completed a series of investigations of the geology of New York City. He has mapped out a scheme to save borings or explorations for any project in the city, such as aqueducts,

tunnels or building foundations. Professor Berkey has constructed a map of the city on which will be plotted the findings of such borings to be used for future reference. In this way the substrata of the entire city will in time be plotted on the map and engineers working on any project will be spared the trouble and expense of new determinations.

Before the Geographical Society of Chicago on January 14 there was an illustrated lecture by Mr. Anthony Fiala entitled "Through the Brazilian Jungles with Colonel Roosevelt"; on January 28, Professor William I. Thomas, of the University of Chicago, will lecture on "The Comparative Mental and Moral Worth of Races."

Dr. Frank G. Speck, assistant professor of anthropology in the University of Pennsylvania, lectured before the Geographical Society of Philadelphia on January 14 on "Hunting Territories and Game Rights of the Tribes of the Lower St. Lawrence."

At the 221st meeting of the Elisha Mitchell Scientific Society, held in the Chemistry Hall of the University of North Carolina on December 14, the program consisted of an address on "Some Phenomena of Fluid Motion and the Curved Flight of a Baseball," by Dr. W. S. Franklin, formerly professor of physics, Lehigh University. On December 20 Professor Franklin delivered a lecture at the laboratory of the Department of Terrestrial Magnetism at Washington, entitled, "On the Limitations of One-to-one Correspondences in Physics."

Dr. L. A. Bauer gave an illustrated address at the Carnegie Institution of Washington on December 9 on "Our Earth a Great Magnet."

Dr. J. J. Tauberhaus, associate plant pathologist of the Delaware Experiment Station, will deliver the John Lewis Russell lecture before the Massachusetts Horticultural Society on March 27, on "Diseases of Sweet Peas."

At the annual meeting of the trustees of the Adirondack Cottage Sanatorium, December 21, Dr. Walter B. James, New York City, was elected president; Dr. Edward R. Baldwin, Saranac Lake, vice-president; Mr. George S. Brewster, secretary-treasurer, and Dr. Frederick H. C. Heise, Trudeau, resident physician. The trustees adopted a resolution paying tribute to the memory of Dr. Edward L. Trudeau and directing that this tribute be spread on the records of the meeting.

The *Journal* of the American Medical Association states that the *Presse Médicale* gives an illustration of the large tablet to be erected under the arcade of the great staircase of the medical department of the University of Paris. In October the design, already in place, contained the names of six members of the faculty, victims of the war (Galland, Legrand, Moog, Pelissier, Schrameck and Reymond—the latter the aviator). There are also inscribed the names of forty-seven students, and of twenty-six former graduates of the institution. Landouzy comments on this total of seventy-nine medical victims that the new methods of warfare have incredibly increased the dangers and privations of the medical men with the army. They keep right with the men in the trenches and toil on while others sleep.

Francis Marion Webster, of the Bureau of Entomology, died on January 3 in Columbus, O., at the age of sixty-six years.

Dr. James Clarke White, adjunct professor of chemistry in the Harvard Medical School from 1866 to 1871, and professor of dermatology from 1871 until his retirement as professor emeritus in 1902, died on January 6, in his eighty-third year.

Professor Robert James Davidson, since 1891 professor of chemistry at the Virginia Polytechnic Institute and dean of the scientific department, died suddenly on December 19, in his fifty-third year.

Dr. Walter L. Capshaw, for seven years professor of anatomy at the University of Oklahoma, died suddenly of pneumonia at his home in Norman on Christmas morning. He was a graduate of St. Louis University and intended studying in one of the eastern schools while on sabbatic leave this year, but was prevented on account of ill health.

Dr. Charles Clifford Barrows, professor of gynecology at the Cornell University Med-

ical College, died on January 3, aged fifty-nine years.

DR. JOSEPH J. O'CONNELL, health officer of the port of New York, lecturer on hygiene in the New York University and lecturer on public health in the Long Island College Hospital, died on January 1, at the age of forty-nine years.

DR. W. A. BORGER, assistant director of the Pasteur Institute and vaccination service in Java, has died, aged forty years. He succumbed to laboratory infection from research on bubonic plague.

THE death of Dr. Jules Ville, professor of medical chemistry at the Faculté de Montpellier, is announced.

THE annual general meeting of The American Philosophical Society will be held on April 13, 14 and 15, 1916, beginning at 2 P.M. on Thursday, April 13.

THE sessions of the fourth annual meeting of the New York State Forestry Association will be held at Syracuse on January 21. The program has been considerably broadened and in addition to discussing forests as producers of timber there will be considered the necessity of the forests in controlling the run-off of water, the forests as a recreation place and as a home for fish and game. The Honorable Gifford Pinchot and Chief Forester Graves, of the U. S. Forest Service, have been invited to speak. The list of speakers will include also John B. Burnham, president of the New York State Fish, Game and Forest League, who will give an illustrated address on game protection and propagation, and Dean Baker, of the State College of Forestry at Syracuse, who will speak on forests and the conservation of water in the state.

THE directors of the Fenger Memorial Fund announce that $550 have been set aside for medical investigation in 1916. The money will be used to pay all or part of the salary of a worker, the work to be done under direction in an established institution, which will furnish the necessary facilities and supplies free of cost. It is desirable that the work undertaken should have a direct clinical bearing. Applications should be addressed to Dr. Ludvig Hektoen, 637 S. Wood St., Chicago.

THE *Journal* of the American Medical Association reports that President Wilson will submit to congress a plan for a system of public health hospitals to take the place of the present condition of contract care of patients and government hospital service. The first step will be to take over the meteorological research station at the summit of the Blue Ridge, Mount Weather, Va., and convert it into a hospital for sailors and other patients from the Atlantic seaboard. Within another year locations will be selected for hospitals in southern California and the southeastern part of the United States.

UNDER date of December 8, from Rome, the trustees of the Permanent Wild Life Protective Fund are informed by Frederic C. Wolcott that "the Italian Government has at last passed a law, which goes into effect on January 1, prohibiting the shooting of all song and insectivorous birds throughout Italy." If this prohibition also includes, as it is only fair to assume that it does, the netting of all such birds, then Italy has indeed carried into effect a great reform. The importance of this action to the birds and the crops of Europe is beyond computation. Hitherto the netting of song birds while on their migrations has been a widespread industry, and the deadly roccollo has each year slaughtered hundreds of thousands of the choicest song-birds of Europe for food. Both in America and in England this abuse has been severely denounced, and an American bird protector has declared that it was "a reproach to the throne of Italy." The causes which brought about this reform in Italy, in spite of the excitement of war, are as yet unknown.

THE *American Museum Journal* states that the large collection of prehistoric pottery collected by Mr. Algot Lange on the island of Marajo has been acquired by the American Museum. Marajo Island in the mouth of the Amazon River is 165 miles long by 120 wide, and belongs to Brazil. A collection of some two thousand pieces comes from Pacoval Island in Lake Aray, the source of the Aray

River. Mr. Lange described the little island of Pacoval as an archeological mine. Fragments of pottery cover the ground and everywhere the earth is mixed with pottery ranging in size from minute pieces to vessels weighing as much as twenty-five pounds. Nothing is known of the makers of this ware. Who they were or where they came from is at present a mystery, but it is hoped that a study of the unique and beautiful decorations on the pottery will afford some information on the point.

The Bureau of City Tests of the University of Cincinnati has submitted its annual report through Director E. K. Files. The report states that 1,024 samples have been examined, including coal, cement, gas, soot fall, oil, asphalt and soap. Less than one per cent. of the samples received have been rejected because of inferior material, so that the city in its purchases is enforcing a high standard of quality. New developments in the bureau are as follows: (1) Two cooperative chemical engineering students are employed in the laboratory to give supplementary tests and more complete analyses; (2) since last May, atmospheric pollution in Cincinnati has been studied. The deposits collected in various districts of the city are analyzed each month and the difference in composition of carbon, tar, acids, etc., between the street level and upper stories of buildings in the downtown districts is being worked out. This study will continue and is valuable for showing the effectiveness of smoke-prevention work. Other interesting investigations now being made are on the influence of the composition of coal on the fusibility of the ash and the causes of variation in the density of natural gas during the different seasons. The bureau is now doing work for the following departments of the city: Engineering, Sewerage, Purchasing, Street Lighting, Board of Education, University of Cincinnati, Park, Fire and Smoke Inspection Bureau.

The recognition by citizens generally that the Geological Survey is a bureau of information as well as a field service has gradually placed upon it a large burden of work as well as of responsibility. The amount of correspondence involved in performing this public duty may be indicated by the fact that approximately 50,000 letters of inquiry were handled in the different scientific branches of the survey last year. The scope of these inquiries is not less noteworthy, for they range from requests for information concerning the geology of every part of the United States or the water supply, both underground and surface, of as widely separated regions as Alaska and Florida, or for engineering data on areas in every state in the union, to inquiries regarding the natural resources of foreign countries, especially those of Central and South America. The changes in the world's trade in metals and other mineral products during the last year brought to the Geological Survey a new opportunity for special service. The inquiries concerning possible sources of this or that mineral product began early in August, and the Secretary of the Interior gave to the public an interview outlining the expected developments in the mineral industry. His statement was followed by special press bulletins issued by the survey on the more important subjects. In September, 1914, however, the demand for authoritative information had become so lively that a bulletin—"Our Mineral Reserves" was issued. In this publication the subject of the country's ability to meet the emergency demands for minerals was summarized and the survey offered to serve as an agent in bringing consumer and producer into touch with each other. This new function of acting as "central" to the mineral industry proved popular, a large volume of special correspondence developed, and a gratifying use was made of the Geological Survey's list of mineral producers and of the specific information in the possession of the federal geologists regarding practically every type of mineral deposit in the country. It is believed that this correspondence has been of material advantage to consumers and producers alike—the users of mineral products who were formerly dependent upon foreign sources of supply and the mine operators who have learned of new markets for their output.

The Department of Agriculture is taking action, through the Biological Survey and the Forest Service, to combat a serious wave of

rabies infection of wild and domestic animals that is in danger of becoming wide-spread in the far west. The fact that the extensive dissemination of the disease is taking place through the agency of coyotes makes the situation a difficult one to meet. Outbreaks of rabies among coyotes have been noted from time to time for several years in parts of Washington, Oregon and northern Idaho, and the Forest Service undertook last year to aid in bringing the disease under control by employing hunters to make war on coyotes in the National Forests of some infected localities. Since, however, the coyotes breed in the foothills and around the outskirts of the forests, a more comprehensive campaign is called for. The eradication of coyotes in sparsely settled or rough country is said to be an exceedingly difficult task. Inasmuch as these animals are always a source of considerable losses to the livestock industry of the west, congress last year provided a special fund of $125,000 to be spent by the Biological Survey for the eradication of predatory animals both in the national forests and on the public domain, and from this fund a special allotment has now been made to provide for fighting the rabies. The disease first appeared in parts of eastern Oregon and Washington and northern Idaho, in a region surrounded by natural barriers which tended to confine the outbreak. Domestic animals and human beings were bitten, and a good deal of alarm was manifested by residents of the infected districts, many of whom feared for the safety of their children on the roads to and from school. The disease is now reported as having extended into northern Nevada and northern California, whence it may easily be carried far. The Forest Service, the Biological Survey and the State Board of Health are working together to meet the situation in California. Modoc and Lassen counties have been put under quarantine by the state board, which has appointed forest rangers inspectors in Modoc County. Funds have been provided by the Biological Survey for the employment of additional men and the purchase of traps and poison. The public will be enlisted in the campaign, which will be led by the Biological Survey officials and the forest rangers.

UNIVERSITY AND EDUCATIONAL NEWS

WESTERN RESERVE UNIVERSITY has purchased twelve acres of land adjoining its present site and increasing it from 23 to 35 acres. The amount paid for the land is not made public, but the tax valuation is $230,000.

FOUR business men of Portland have contributed $25,000 toward the new buildings for the Medical Department of the University of Oregon, Portland. This makes available the $50,000 appropriated by the state. The officers of the college now propose to raise an additional $100,000.

OVER $3,500 worth of chemicals, scientific glassware and other laboratory supplies ordered by the University of Washington from Germany a year ago, but held up at Rotterdam, will shortly reach this country. The British embassy has advised government officials that importation will not be prevented any longer.

A RECENT fire is said to have caused $50,000 damage to the Havemeyer chemical laboratory of New York University.

DR. OWEN L. SHINN, professor of chemistry in the University of Pennsylvania, has been appointed director of the university summer school.

THE following new appointments have been made in the Western Reserve Medical School: Dr. J. Rogoff, formerly of the department of physiology and pharmacology, Vanderbilt Medical School, Nashville, to be instructor in experimental medicine; Dr. C. H. Fiske, formerly assistant in biological chemistry, Harvard Medical School, to be associate in biochemistry; Dr. R. W. Scott, formerly demonstrator of medicine, Western Reserve University, to be instructor in physiology.

DISCUSSION AND CORRESPONDENCE

THE DETERMINATION OF NITRATES IN SOILS

IN the June number of the *Journal of Industrial and Engineering Chemistry* appeared an interesting article by E. R. Allen, of the Ohio Agricultural Experiment Station, en-

titled, "The Determination of Nitric Nitrogen in Soils," in which several of the older methods for determining this elusive radical received extended and probably deserved criticism.

Among those receiving its full share was the aluminum reduction method proposed by the writer a little over two years ago. The title of the article proclaiming this method was, "The Aluminum Reduction Method as applied to the Determination of Nitrates in 'Alkali' Soils." It was at that time put forward by the writer, not as the best possible method that the future might develop for this purpose, but as one which, in the presence of the soluble chlorides, sulfates and carbonates abounding in the "alkali" soils of the arid west, would give far more reliable results than the phenol disulfonic acid method of Gill then commonly used in soil work. Comparisons with this latter method are given. Another reason for developing the method in question was to accurately determine nitrates in nitrification cultures in soils containing one or more of the "alkali" salts. Occasionally large amounts of nitrates are here encountered, and, as was shown, when more than twenty or twenty-five milligrams of nitrogen as nitrate are present, the colorimetric method previously mentioned is of questionable value even in the absence of "alkali."

Briefly, the criticism of the method as made by Allen is that very high amounts of soluble humus and organic matter cause incomplete reduction, the results running low.

As all soil scientists know, the "alkali" soils of California and other arid sections are *very low* in soluble organic matter commonly termed humus.[1] They vary from almost nothing to, in some few cases, 3 per cent. The average for the surface soils of California is 1.28 per cent. It was for these soils, and not for those high-humus soils of the middle west, that the aluminum reduction method was originally intended. It was satisfactorily tried out with varying amounts of the "alkali" salts singly and combined, also with soluble organic matter in the forms of glucose and soluble humus, in amounts far in excess of that ever leached from "alkali" soils with distilled water.

The writer admits that some of the statements made for the accuracy of his method were possibly too broad and far-reaching, but they were made more especially with reference to its application to "alkali" soils, as the title should suggest. The method, as proposed, has been successfully used by others in arid sections, and the author still recommends it for use under such conditions.

In conclusion the writer wishes to state that he will be the first to welcome any method for determining nitrates in soils which combines accurate and reliable results with a minimum of time expended.

Note.—Since the above was written (July last) an article entitled "The Determination of Nitrates in Soil," by R. S. Potter and R. S. Snyder[2] has appeared in which the aluminum reduction method, proposed by the writer and criticized by Allen, is shown to be far superior to the colorimetric methods even where the high humus soils of Iowa were used.

P. S. Burgess
The Experiment Station of the
Sugar Planters Association,
Honolulu, H. I.

[1] See "Humus and Humus-nitrogen in California Soil Columns," University of California Publication in Agricultural Science, Vol. 1, pp. 173–274, by R. H. Loughridge.

A SIMPLE METHOD FOR THE ELIMINATION OF PROTOZOA FROM MIXED CULTURES OF BACTERIA

Protozoa, particularly various flagellates and ciliates, often hamper the study of the higher bacteria in mixed cultures.

Such cultures may be readily and effectively freed from these undesired animals by centrifugalization. By this means protozoa are quickly thrown to the bottom of the tube, while the bacteria for the most part remain in suspension. If subcultures are then inoculated from the supernatant fluid they will be found entirely freed from protozoa.

Doubtless this "fractional" centrifugali-

[2] *Jour. Ind. and Eng. Chem.*, Vol. 7, No. 10, p. 863.

zation has been previously practised by other workers, but as I have never seen mention made of it, I bring it to the attention of bacteriologists.

HENRY N. JONES

SYRACUSE UNIVERSITY

SCIENTIFIC BOOKS

Cancer, Its Cause and Treatment. By L. DUNCAN BULKLEY, M.D. New York, Paul B. Hoeber, 1915.

Various writers, especially Williams in his book on the natural history of cancer, have attributed great significance to the mode of life, especially to the diet as a factor in the origin of cancer. He pointed out that cancer is much less frequent among races which are vegetarian. Dr. Bulkley defends in his lectures a similar thesis: cancer (both carcinoma and sarcoma) is due to errors in the mode of living, not only to an overindulgence in a meat diet, leading to the production of nitrogenous poisons which are not properly eliminated, but also to the consumption of tea, coffee and alcohol. In consequence the saliva becomes acid, increased putrefaction takes place in the large intestines, the glands with internal secretion do not functionate well, the kidneys cease to secrete sufficiently, and the body fluids which bathe the cells become abnormal (especially too acid), thus stimulating certain embryologically aberrant cells to cancerous growth. Other factors, like traumatism play only a secondary part. In support of his views the author cites statistical data which show that frequency of cancer is greatest where so-called civilization has farthest advanced, that the increase in cancer which is observed everywhere is real and caused by a corresponding increase in false living; that experimentally it has been shown that the growth of (transplanted) cancer in animals can be influenced through certain diets; that clinically, cancer has been cured by the author in a considerable number of cases by instituting an appropriate mode of living aided by the use of drugs stimulating elimination of waste products and certain other procedures.

It is impossible to enter into a detailed critical analysis of this position. We must, however, point out that throughout the author's argumentation no sharp distinction is made between fact and hypothesis. Facts opposed to his thesis are ignored or minimized in their importance. We may mention a few objections which might be raised: We do not know at the present time how much the mode of living, external conditions and hereditary factors influence the distribution of cancer among different people. We know that constant irritation of certain kinds may produce cancer in a large percentage of persons, provided the irritation is active over a sufficiently long period of time. We have shown that on the same mouse farm in Granby, under the same vegetarian diet, certain strains of mice are almost exempt from cancer, while in other strains, as a result of hereditary peculiarities, the large majority of all females become affected by cancer of the breast. It is now known that the presence of embryologically displaced cell nests is not necessary for the development of cancer.

There occur in addition to the main arguments not infrequently statements which are open to criticism. To cite a few: "The cells themselves must be influenced ultimately by that mysterious force which we will call life, which ends with its extinction from the body as a whole and which is ultimately related to nerve action." The thyroid is said to be of great importance in governing the calcium metabolism. The same principles are said to hold good for the treatment of skin diseases and for cancer in general, because both concern aberrations in the behavior of epithelial cells; but internal organs like pancreas and liver, although they are of epithelial character, nevertheless do differ in their behavior from the skin. Postoperative recurrences of cancer are, according to the author, due to a transformation of formerly healthy cells into cancer cells as a result of faulty metabolism and not, as is almost generally assumed, to the incomplete removal of the original cancer.

LEO LOEB

The Cancer Problem. By William Seaman Bainbridge. The Macmillan Company, 1914.

Within the last decade several books have appeared dealing with the cancer problem; those of Carl Lewin, P. Menétrier, W. Roger Williams, W. H. Woglom, and the encyclopedic work of Jacob Wolff may be especially mentioned. Of those written in the English language, the book by Williams appeared seven years ago and Woglom's work treats mainly of experimental cancer research.

Dr. Bainbridge considers the cancer problem from many aspects; being a surgeon, however, the author devotes the greater part of his book to the clinical aspect of cancer (274 pages), while to the scientific side proper 142 pages are given. In the clinical part the author gives much first-hand experience, while in the scientific part he leans more or less on the judgment of others, especially on the writings of Bashford, and this part represents in part a summary of the reports of the English Cancer Research Fund. The book on the whole is well written and contains much interesting information. If in the following we mention a few of the errors which we find here and there, and take issue with some of the views expressed and with the author's treatment of certain aspects of scientific investigation, our purpose is not to detract from the value of the book as a whole.

In Section I. a survey of the various institutions and associations for the study of cancer is given. The American Association for Cancer Research did not come into existence in 1912 (p. 28), but was founded a number of years previously. On page 7 the "famous Althoff" who promised the aid of the government to the German Society for Cancer Research, is erroneously designated as "Kultus minister." The German society as such was not committed to the parasitic theory of the origin of cancer, for although some members supported this hypothesis, other important members, notably Orth and Von Hansemann, opposed it.

In Section II. we find a discussion of the botanical distribution of cancer. The analogy between crown gall and animal cancer is not accepted "since it presupposes the parasitic origin of cancer," and since "notably the presence of the parasites in Smith's secondary growths is in contradiction to the way in which secondary growths arise in man." In reality we can not be certain that even in man in certain tumors included among cancers, parasites are not within the tumor cells which give rise to the metastases. In the chapter on the zoological distribution, it is stated that the evidence is conclusive that benign as well as malignant tumors may occur in any multicellular organism. Whether typical cancer occurs at all in invertebrates is doubtful; certainly in the large majority of classes of invertebrates no cancer has been found. Carcinoma of the caruncula seems to be the most common site of cancer in cattle in various parts of America, not only in Wyoming, as might be inferred from the author's statement.

As to the ethnological distribution and cancer statistics the probabilities are very great indeed that the cancer rate among the African negro, the natives of Guinea and the American Indian is considerably lower than among the whites in Europe and America. The especially interesting data of Levin concerning cancer among the American Indian are not mentioned by the author. The value of possible objections to the conclusion that the cancer incidence is very different in different races seems to be overestimated. The author accepts as correct Murray's work on heredity of cancer in mice, which leads to the conclusion that heredity is responsible for a difference of only 10 to 15 per cent. in the cancer incidence in mice; in common with Bashford he attributes therefore only slight importance to the factor of heredity. As a matter of fact Murray's work is based on false premises and it proves neither the presence nor the absence of hereditary factors. Bainbridge makes no mention of more recent investigations carried on in Granby, Mass., and in Chicago, which indeed prove the great significance of heredity in cancer of mice, accounting for as great a

difference as 90 per cent. between some strains.

In Section IV. the various hypotheses concerning the origin of cancer and in a second chapter the predisposing causes are discussed. Ehrlich's "atreptic theory" ought to have been included in the first chapter; it is, as far as the etiology of cancer is concerned, a mere hypothesis and not one of the "predisposing causes." Long-continued action of Roentgen rays might almost be considered as "essential" and not merely a "predisposing" cause, if we bear in mind the great number of early Roentgen-ray operators who developed cancer of the exposed skin. The argumentation of C. P. White, apparently refuting as unthinkable a parasitic origin of cancer, is given in detail. Notwithstanding this argumentation, certain sarcomata of fowl which in their behavior seem to be distinguishable from human sarcomata, may perhaps be caused by microorganisms.

The section in histopathology contains a series of clear drawings. The description is of necessity brief. The purely local origin of cancer is emphasized. The origin of rodent ulcer is declared to be still uncertain, despite the fact that recent investigations have undoubtedly shown that in certain cases at least it originates in the epidermis.

Section VI. deals with "Cancer Research — a Résumé of the World's Work." The author has in view especially experimental research. Thirty-six pages are devoted to this chapter. Here we have to deal mainly with a résumé of the work of the English Cancer Research Fund. American work is to a great extent ignored. Not rarely when a fact established by an American author is mentioned, the author's name is not mentioned, so that a reader unfamiliar with the history of cancer research would be inclined to attribute the work to the English cancer research and to conclude that American research played a very subordinate part in this field. Such an assumption, however, would be incorrect, and it is to be deplored that much of the important work of Tyzzer, Gaylord, Flexner and Jobling, Weil, Levin, Sweet, Corson-White and Saxon, Fleisher and others is not mentioned. Peyton Rous's name is omitted in the brief reference to his work in this chapter. The early work on Chicago rat sarcoma is entirely omitted, although the survival of the tumor cells after transplantation had been demonstrated at an early period of this investigation.

It is not possible to go into a detailed criticism of some of the views expressed in this chapter; we may mention, however, a few statements with which issue might be taken. Bashford's and Murray's views as to the rhythm of tumor cells is accepted as proven; the work of other investigators (especially M. S. Fleisher) who arrived at different conclusions, is ignored. It is taken for granted that tumor cells differ from ordinary tissue cells in their potential power of unlimited growth, while on the contrary this characteristic is common to both kinds of cells and the difference consists essentially in the increase in cell multiplication in the case of tumor cells, as the reviewer pointed out many years ago. The fact that animals can, through immunization, be protected against successful inoculation with foreign, but not with their own tumors, is erroneously assumed to prove that no external element can be concerned in the origin of cancer, while this fact merely proves that an organism usually can be immunized much more readily against foreign cells than against its own, and also that in the first origin of tumors other factors are concerned than in the continued growth of established tumors. No conclusion can be drawn from this fact as to the presence or absence of parasites within the tumor cell. The work of Uhlenhuth which to a great extent disposes definitely of the hypothesis of athrepsia, is not mentioned.

In the second part, dealing with the clinical aspect of cancer, the clinical course of the disease, diagnosis, prophylaxis, treatment by surgical and non-surgical means, are discussed. Various quack treatments are also described. Especial attention is given to Handley's work dealing with the extension of mammary cancer, to the fulguration treatment and thermoradiotherapy of de Keating

Hart, to electro-coagulation and to the author's negative results with Beard's methods of treating cancer with injections of pancreatic ferments, as well as to the author's method of starvation ligature of blood vessels and lymphatic block in advanced cancer of pelvic organs. The wide experience of the author in this field, his insistence on applying the results of theoretical research in clinical surgery, give especial value to this, the larger part of the book. This work ought therefore to have a wide circulation especially among physicians. Here it can do much good. To the scientist who will keep in mind some of the limitations of this book, it will give a conception of the great variety of problems and methods in cancer research.

Leo Loeb
Washington University

The Age of the Ocala Limestone. By Charles Wythe Cooke. U. S. Geol. Surv., Prof. Paper 95–1, 1915. Pp. 107–117.

In the first half of the last century it was assumed by American geologists of the Atlantic seaboard that certain extensive calcareous formations in the Carolinas represented terranes intermediate between the Cretaceous and lowest Tertiaries of Europe, or, perhaps were "newest Cretaceous." This assumption seems to have been made on account of the prevalence of light-colored, calcareous matter, chalk, in the upper Cretaceous of the Old World; the lithological resemblance of certain Cretaceous beds in New Jersey to calcareous beds of the south; the supposed identity of certain molluscan species from both areas; and the admixture of fossils from different horizons (really brought about mechanically, or from careless collecting). Lyell took a keen interest in this strange formation in America, and with his skill in observation "on the spot," was able to place these "white limestones" in the Eocene, to the satisfaction of all.

Again in our Eocene stratigraphy we see how a few accurate observations in the field have upset our notions regarding sequence of formations; this time, however, it is the "Ocala limestone" so-called (yet strangely enough largely equal to Lyell's "white limestone"), that has been the misplaced member. Here, too lithological resemblance, preconceived notions in faunal resemblances and unhappy identifications have been at the base of the trouble. Mr. Cooke's observations on the fauna of the beds beneath the St. Stephen's limestone in Alabama, has led to the identification of the same with the Ocala beds of Florida. The preliminary paleontological proof he brings to bear in favor of his contention seems very satisfactory. The Ocala limestone, therefore, is upper Eocene (Jacksonian) and below the Marianna limestone, and not upper Oligocene and above the Marianna as heretofore held. The importance of this revelation on the geological mapping of Florida is patent to all. We take great pleasure in seeing the distinctness of *Pecten poulsoni* and *P. perplanus* biologically and stratigraphically emphasized. The "Ocala limestone fauna" as modified by Cooke (p. 111) has a most decidedly Jacksonian aspect. The "*Mitra* like *millingtoni*" is quite probably that species for I have found it above the Claiborne "sand" at Claiborne, Alabama, thus well on towards Florida from Jackson, Miss. *Scaphander grandis* is a most remarkably characteristic Jacksonian form. Judging by trans-Mississippian faunas, we should expect soon to find in the Ocala such dominant forms as the Fulguroid *Levifusus branneri,* varieties of *Mazzalina inaurata;* and we already have traces of the high-spired "*Amauropsis*" in Dall's *A. ocalana.* Incidentally, with the Jackson age of the Wilmington beds established, it will be interesting to watch the final disposition of the following references:

Paludina (cast), Wilmington, Jr. Geol. Soc. Lond., Vol. 1, 1845, p. 431, text fig. *c.*

Viviparia lyelli Con., Am. Jr. Conch., Vol. 1, 1865, p. 32.

Polynices (*Amauropsis*) *ocalana,* Dall, Tr. Wagner, Ins. Sci., Vol. III., 1892, p. 377.

Amauropsis Jacksonensis Harris, Proc. Phila. Acad. Nat. Sci., 1896, p. 474, pl. XIX., fig. 3.

G. D. Harris
Paleontological Laboratory,
Cornell University

SPECIAL ARTICLES

PERIDERMIUM HARKNESSII AND CRONARTIUM QUERCUUM

INOCULATIONS of *Pinus radiata* with æciospores of *Peridermium harknessii* on *Pinus radiata* made in the spring of 1913 resulted in typical galls during the same year. In the spring of 1915 some of these galls bore æcia of *Peridermium harknessii*. The check plants remained sound.

The mycelium of *Cronartium quercuum* on the evergreen *Quercus agrifolia* overwinters in the old green leaves and in early spring produces sori of uredospores in a circle around the old *Cronartium* spots; the uredinial sori on the young leaves are the results of infection from the sori on the old leaves. If *Peridermium harknessii* connects with *Cronartium quercuum*, we have here a case of facultative heteroecism in both generations.

E. P. MEINECKE

OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY,
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A SIMPLE DEMONSTRATION OF THE REDUCED VAPOR PRESSURE OVER A SOLUTION

W AND *S* are two small glass crystallizing dishes. *W* is half filled with water and *S* with a strong solution of some salt. *P* is a piece of

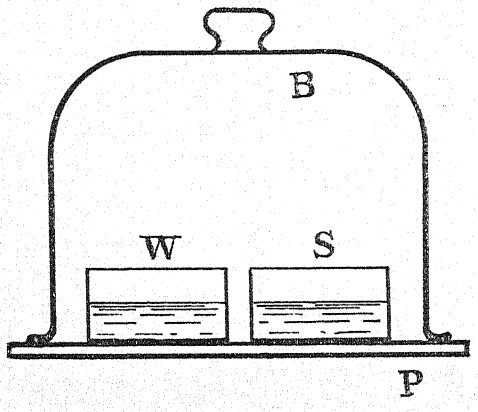

plate glass and *B* is a bell jar. For equilibrium the pressure of the vapor above *S* would have to be less than that above *W*. For this reason the water gradually distills from *W* into *S*.

This result is so obvious that the experiment has no doubt been carried out before. However in a recent brief examination of the literature of the reduction of vapor pressure by solution I have found no reference to it, although Moser[1] clearly indicates the possibility of such an experiment. In his work he used two U tubes, one for the water and one for the solution. One end of each tube was closed, and the open ends were joined—so that with a connection to an air pump these open ends formed a fork. Moser says:

> Das Lumen dieses Gabelrohrs ist eng, ein bis zwei Millimeter, um eine Ueberdestilliren des Dampfes vom Wasser zur Lösung zu erschweren.

In my experiment, which I carried out three years ago, the dishes *W* and *S* were about 5 cm. in diameter and *S* contained a solution of about 1 g. of sodium chloride to each 5 g. of water. Vacuum wax was run around *B* where it rested on *P*, but no attempt was made to reduce the air pressure in *B*. The apparatus stood in a room at ordinary laboratory temperature from January 26 to March 21. At first I set out to examine the rate at which the liquid surfaces changed their levels, but the sides of *B* were not smooth enough to admit of making through them any readings that were worth while. At the start the levels were about the same, and after somewhat less than two months the surface of the solution was 9.0 mm. higher than that of the water.

ARTHUR TABER JONES

SMITH COLLEGE,
January 23, 1915

THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-second annual meeting of the society was held at Columbia University on Monday and Tuesday, December 27–28, 1915. Seventy-two members attended the four sessions. President E. W. Brown occupied the chair, being relieved by Professor Edward Kasner. The following new members were elected: Professor W. E. Edington, University of New Mexico; Professor J. L. Gibson, University of Utah; Dr. W. E. Milne, Bowdoin College; Professor L. J. Reed, University of Maine. Nine ap-

[1] *Wied. An.*, 14, p. 73, 1881.

plications for membership were received for action at the next meeting.

The total membership of the society is now 736, including 72 life members. The total attendance of members at all meetings during the past year was 418; the number of papers read was 197. The number of members attending at least one meeting during the year was 253. At the annual election 204 votes were cast. The treasurer's report shows a balance of $10,470.58, including the life membership fund of $5,560.30. Sales of the Society's publications during the year amounted to $1,832.93. The library now contains about 5,250 volumes.

Sixty members and friends attended the annual dinner of the society on Monday evening.

At the annual election on Tuesday morning the following officers and members of the council were chosen:

Vice-Presidents: E. R. Hedrick and Virgil Snyder.

Secretary: F. N. Cole.

Treasurer: J. H. Tanner.

Librarian: David Eugene Smith.

Committee of Publication: F. N. Cole, Virgil Snyder, and J. W. Young.

Members of the Council to serve until December, 1918: G. A. Bliss, R. D. Carmichael, W. B. Fite, and F. S. Woods.

The following papers were read at this meeting:

J. F. Ritt: "On the derivatives of a function at a point."

J. F. Ritt: "The finite groups of a class of functions of a real variable."

J. E. Rowe: "A new method of deriving the equation of a rational plane curve from its parametric equations."

H. B. Phillips: "Elastic nets."

Arthur Ranum: "The singular points of analytic space curves."

H. M. Sheffer: "The reduction of non-monadic relations to monadic."

H. M. Sheffer: "The elimination of modular existence postulates."

Bessie I. Miller: "A new canonical form of the elliptic integral."

A. R. Schweitzer: "On the use of supernumerary indefinables in the construction of axioms."

Dunham Jackson: "Algebraic properties of self-adjoint systems."

G. D. Birkhoff: "On dynamical systems with two degrees of freedom."

G. D. Birkhoff: "Infinite products of analytic matrices."

Tomlinson Fort: "Linear difference and differential equations."

E. B. Wilson: "Ricci's absolute calculus and its application to the theory of surfaces."

C. L. E. Moore: "Some theorems regarding two-dimensional surfaces in euclidean n-space."

Olive C. Hazlett: "On the fundamental invariants of nilpotent algebras in a small number of units."

Edward Kircher: "Some properties of finite algebras."

M. Fréchet: "On Pierpont's definition of integrals."

Edward Kasner: "Infinite groups of conformal representations."

Joseph Lipka: "Isogonal, natural, and isothermal families of curves on a surface."

L. L. Silverman: "On the consistency and equivalence of certain generalized definitions of a limit of a function of a continuous variable."

L. P. Eisenhart: "Ruled surfaces generated by the motion of an invariable curve."

L. P. Eisenhart: "Transformations of surfaces Ω (second paper)."

G. M. Green: "On rectilinear congruences and nets of curves on a surface."

W. F. Osgood: "The infinite region."

John Eiesland: "On sphere-flat geometry."

J. L. Coolidge: "The meaning of Plücker's numbers for a real curve."

W. M. Smith: "Characterization of the trajectories described by a particle moving under central force varying inversely as the nth power of its distance from the center of force."

H. H. Mitchell: "On the generalized Jacobi-Kummer cyclotomic function."

H. H. Mitchell: "On the congruence $cx^{\lambda} + 1 = dy^{\lambda}$."

R. D. Beetle: "Sets of properties characteristic of the arithmetic and geometric means."

R. L. Moore: "On the foundations of geometry."

W. C. Graustein: "The correspondence of space curves by the transformation of Combescure and by a transformation thereby suggested."

R. E. Gleason: "On Dirichlet's principle."

W. E. Milne: "On the degree of convergence of Birkhoff's series."

G. C. Evans: "A generalization of Bôcher's analysis of harmonic functions."

J. W. Alexander, II.: "On the factoring of plane Cremona transformations."

L. B. Robinson: "On elimination between several polynomials in several variables."

The Chicago Section of the society held its winter meeting at Columbus, Ohio, in affiliation with the American Association for the Advancement of Science. The next meeting of the society will be held at Columbia University on February 26.

F. N. COLE,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 545th meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, November 20, 1915, called to order by President Bartsch, with 50 persons present.

On recommendation of the council Leo D. Miner, E. O. Wooten, A. M. Groves, all of Washington, D. C., were elected to active membership.

Under the heading Brief Notes, Mr. Radcliffe called attention to recent efforts of the Bureau of Fisheries in rearing shad in ponds. Young fish thus raised attained twice the size of those of the same age in their natural environment. Specimens of both kinds were exhibited.

The first paper of the regular program was by Frederick Knab, "The Dispersal of Some Species of Flies." Mr. Knab said: "The species of Diptera that have been spread beyond their natural habitats through the agency of man are for the most part such as thrive under conditions created by man, many of them having even become his inseparable associates. They are mostly scavengers whose larvæ thrive in spoiled foodstuffs, sewage and excrement of man or domestic animals. The majority of the flies of such habits occurring in North America are unintentional introductions from Europe. It is certain that many other species of flies must have been carried across the ocean repeatedly and yet failed to establish themselves. It is only those species which upon their arrival find conditions suitable for propagation immediately at hand that can be expected to gain a foothold, and most of these will be scavengers. A few striking examples of the wide dissemination of such species by man were given.

"A notable case is the very wide distribution of *Eristalis tenax*, the drone fly, within very recent times. Its natural habitat was Europe, northern Africa and the temperate portions of Asia. It appears to have been first noted in the United States about 1870 and in the course of a decade had spread over the whole country and become abundant everywhere. Osten Sacken already pointed out that its sudden spread was only possible 'when the necessary conditions for its existence (drains, cesspools, sewers, etc.) had been gradually introduced by civilization across the immense plains which separate the Pacific from the Atlantic Ocean.' Most remarkable is that this fly made its appearance in New Zealand in 1888, where the following year it was abundant in both islands. In America and elsewhere *Eristalis tenax* has not invaded the tropics. In North America it ranges southward on the Mexican tableland to Mexico City and even to Orizaba at the edge of the tropical belt. But in the temperate southern portion of South America it has become established with the recent more general settling up of that region. It was first noted at Buenos Aires about 1895 and is now abundant and generally distributed to the Chilean coast. It has become introduced in Cape Colony and the Hawaiian Islands, the records for the latter going back to 1892. It is also established in southern Australia and appears to have been common about Sydney as early as 1892.

"A second species, *Eristalis arbustorum*, has recently become introduced into the United States from Europe. Like the other, it is a sewage breeder. It was first noticed about New York City in 1906 and has already spread westward through Ohio.

"Another recent importation from Europe is the ortalid fly, *Chrysomyza demandata*. This species breeds particularly in horse manure. It was first found in Philadelphia in 1897 and is now distributed over the whole United States.

"Less known are the species which have become cosmopolitan within the tropics, but do not invade the colder portions of the temperate zone. *Volucella obesa* is a large green syrphid fly of scavenger habits. Its original habitat was tropical America, but now it is generally distributed through the tropics of the Eastern Hemisphere, occurring even on remote islands, like Hawaii and Guam.

"A minute fly of the family Borboridæ, *Leptocera punctipennis* Wied. (*Borborus venalicius* O. S.) is similarly distributed. Osten Sacken, who knew of its occurrence in Africa and Cuba, suggested that it may have been brought to America by slave ships. This theory appears plausible, as it has since been determined that this fly breeds particularly in human feces deposited in the open. During the Spanish-American war it appeared in numbers at Miami, Florida, about the military camp, and where, no doubt, the conditions just indicated

existed. It has not been reported from there since, although the locality is often visited by entomologists.

"*Chrysomyza ænea,* a fly common in the Orient and breeding especially in manure, is of particular interest on account of its very recent appearance within the United States. It was first found in August of this year and so far only in one locality in Louisiana. It appears to have been established in Brazil for some time and very likely occurs in intervening territory, although we have no information on this latter point.

"Another cosmopolite of tropical and semi-tropical distribution is *Milichiella lacteipennis,* a minute fly of the agromyzid series. This also, there is good reason to believe, is a manure breeder.

"A limited number of species are disseminated through both temperate and tropical regions. The house fly, stable fly and certain species of *Drosophila* will at once come to mind as faithful companions of man everywhere. Most remarkable, there is in this category a minute and very frail fly of the family Psychodidæ, *Psychoda alternata.* The flight of this mere mote is exceedingly weak and it clings to sheltered situations. It breeds particularly in sewage and often occurs in sewers in countless numbers. This fly has been received or reported from Europe, North Africa, the United States, Mexico, Guiana, Chile, Hawaii, India and Australia, and no doubt it occurs whenever a sufficiently dense population supplies the requisite conditions."

The second paper was by Alex. Wetmore, "Notes on the Habits of the Duck Hawk." Mr. Wetmore said: "In observations made on the Bear River marshes, Great Salt Lake, Utah, it was found that duck hawks do much of their hunting for food in early morning. Later in the day they pursue any flying bird merely for the pleasure of the chase, seldom killing." Several incidents illustrating this were related.

The last paper of the evening was by Elmer D. Merrill, "Geographic Relationships of the Philippine Flora." Mr. Merrill based his conclusions after the examination of large numbers of living and herbarium specimens from the Philippine Islands, the Malayan Archipelago, the Asiatic mainland, Celebes, New Guinea, Australia, etc. The speaker discussed, in a general way, the geographic position of the Philippine Archipelago with reference to surrounding land areas and the general character of the flora, calling attention to the fact that the vegetation is dominantly Malayan. The probable condition of the vegetation before the advent of man in the Archipelago was a continuous primeval forest. Hence in discussing geographic relationships of the flora, the vegetation of the settled areas and open country generally must be excluded from consideration as presenting special alliances. Likewise the coastal vegetation must be ignored, the species being practically all disseminated by ocean currents. Serially the speaker discussed the striking Asiatic elements in the flora of north central Luzon, largely continental and especially Himalayan foothill types; the weak special alliances of the Sunda group of islands, especially Borneo; the remarkably strong evidences of relationship with the Molucca Islands, especially Celebes, to the south; New Guinea; the numerous Australian (Queensland) types; New Zealand, and Polynesia. The botanical evidence points to weak connections in past ages with Borneo and the Sunda Islands, but to strong or longer continued connections with the islands to the south and southeast. Without such conections to the south and southeast it is practically impossible to explain the strong special alliances of the flora to that of the above regions. That the Philippines and the islands to the south and southeast may have at one time formed the eastern boundary of an ancient continent seems to be probable from the present floristic elements found in the archipelago. It is clear, however, from the remarkably high percentage of endemism as to species (over 50 per cent.) that the islands have been separated long enough to allow for the development of a characteristic flora as to species, but not long enough to develop many distinct genera, the percentage of endemism as to genera being but a fraction of one per cent.

The speaker called attention to the fact that conclusions regarding special alliances of the Philippine flora may be invalidated as exploration progresses, as the floras of Sumatra, Borneo, the Moluccas, and New Guinea, are, comparatively speaking, very imperfectly known, in the case of each probably not more than one third of the species being known, and in some cases even less.

In the discussion which followed Mr. Wm. Palmer, Dr. Stejneger, Dr. Lyon, and Dr. Bartsch discussed the geographic distribution of the Philippine birds, reptiles, mammals and mollusks, which in many respects showed a lack of correlation with the flora, though agreeing in many essentials.

The society adjourned at 10:30 P.M.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

FRIDAY, JANUARY 21, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FORTHCOMING SITUATION IN AGRICULTURAL WORK—II[1]

ONE year ago, at the first meeting of Section M, it was my privilege to speak on some of the tendencies in the great public agricultural movements in the United States, particularly on the educational side, and to express my conviction that the processes set in motion by the Land-Grant Act and subsequent enactments are safeguarding the foundations of our democracy. I approached my subject mostly from the point of view of our present public-service or public-welfare institutions for agriculture; I said that I should discuss the other or non-public phases of the problem one year hence. And now, after twelve months of unrepentance, I come to resume my theme. In continuing the discussion I shall be obliged to reaffirm some of the positions that I urged a year ago.

It is now some seven years ago when I wrote in a book that there may be need of a kind of agricultural work that can best be done in an institution independent of direct state support and not at once responsible to popular will.[2] That statement, or its equivalent, had been made many times theretofore in public ways. I have never taken the privilege, however, to enlarge upon it to any degree: this opportunity is reserved for to-day.

Fortunate it is for us that our educational and to a large extent our civic and welfare work for agriculture have been founded on public funds, thereby committing the state to the necessity of furthering the interests of our basic industry and of

[1] Retiring vice-presidential address, Section M.
[2] "The Training of Farmers," page 225.

making it an active factor in the political establishment. Had all this chain of colleges of agriculture and experiment stations and the great range of extension work and the giving of expert advice been established on private gifts, they would have been philanthropies or at least concessions to a needy industry. The state has recognized the necessity to base itself on the earth, and the enterprise is generously supported.

This, then, is my starting point—that these state-maintained institutions which aim to safeguard and to develop the resources of the earth are essential to permanency in society and also to self-government. Having accepted this basis, we may now ask whether there is need for another set or kind of institutions dealing with the rural situation, or whether such a set would benefit or hinder the public establishments that are now so well developed.

Let me say at once that the field of such institutions, whether public, semi-public or private, is now well understood. The prophetic writings in this nature-field and this agriculture-field are of our own time and of the time just preceding us. The philosophy of the situation, in its great human bearings and in its governmental and social results, has been clearly projected. The fundamental statements have been made. The main forecasts are mostly recent. We are emerging from the generation of search for the underlying elements and of the prophecy for future action. We enter the generation of hopeful and constructive application. At last we begin to see the actual reshaping of country life.

THE PROBLEM OF OVER-ADMINISTRATION

As our philosophy begins now to shape itself into definite action, so do our colleges and experiment stations begin to take on an institutional character. With the passage of the Extension Act, the institutions become real parts in a national system. Administration is now the dominant note in them, whereas formerly the work and attainments of individual men gave them their distinction. In the nature of the case, the administrative forces will increase: the elements must be organized; it is easier and simpler to make plans of administration than to do good research work or superlative teaching. Persons of little training in productive work are now engaged in making plans of administration, a situation that is always dangerous.

It is of the first importance, both to the work itself and to the political democracy we represent, that we do not think of agricultural education and research primarily in terms of organization. In this country where we are all sovereigns and all politicians, it is the easiest thing to slip into political methods, not to say political practises, in education. We must be on our guard against the spiritless domination that is likely to arise in educational and investigational endeavor when it becomes formal, and be aware of those tendencies that confuse red-tape and obstructive duties with administration. An enterprise is not commendable merely because it is "regular" and smooth-running. It is a sad case if personality is ever subordinated to regularity. A man is always more important than a rule.

The tendency toward outside centralized administrative control is well seen in movements now under way in this country to eliminate duplication and conflict between public institutions in a given state by means of one board of control placed over all of them, or by one chancellorship administering all of them from a common office. If it is desirable to conserve the free action and the spirit of a teacher or an officer, as a

means of maintaining the essential forces in a free people without peasantry, so is it necessary also to safeguard the independence of the institution that holds the teachers. Every institution is entitled to its own life.

It would be a vast misfortune if all our state educational institutions were made to be uniform in procedure, even when they are of the same grade or rank. Diversity is the order of nature. We are now run wild in this country in the application of so-called efficiency systems to institutions and agencies that in the nature of their purpose ought to be of the spirit rather than of the letter. Often these systems do not really represent efficiency, but the effort of officers and clerks without either vision or discretion, and perhaps supercilious, to make all things uniform; and more time and money may be lost in this effort than is saved in the purchase of supplies or in the stoppage of the leaks. It is a serious case to deprive the responsible officer of an institution of the right to exercise his discretion.

It is a gross mistake to suppose that management systems usually applicable to a factory can be applied to a college or a university, or to an experiment station or a research laboratory, and for the very good reason that the products are wholly unlike, —manufactured goods in the one case, human souls and scientific truth in the other. So also are the methods of procedure unlike—time-work and a measurable output in the one case, study, reflection, mental recuperation, inspiration, soul-service in the other. The institutions must be allowed to become what they are intended to be.

We are face to face with a struggle to keep educational institutions free not so much from political control as from the deadening domination of fiscal offices. A well-known professor in a college of agriculture writes me that his institution has now become so efficient that he loses one third of his time from all productive work; and another declares that frequently he spends an entire day in making reports that have no significance except to maintain a scheme of administration and which could be performed just as well by a ten-dollar clerk. All this means that we are in immediate danger of developing in our institutions a set of administrative officers, controlling affairs, who are separate in spirit from the real work of research and education. To this tendency add the present peril of similar despotism from state officers, and you have a slowly developing method of strangulation that may well cause alarm.

If you ask me how we are to avoid these duplications and conflicts between state institutions, then I reply that the remedy lies in the constitution of the institutions themselves and not in the method of governance. You can not bring together, by any means of overhead regulation, institutions that in themselves are inharmonious. You may allay the hostilities, by arbitrary regulation you may prevent duplication, but this is not a solution, but only an adjustment; and the arbitrary regulation of finances and accounts will inevitably in the end control the educational policies of the institutions, and will ultimately deprive them of independent free-spirited presidents and leaders. The danger lies in the future rather than in the present. The real remedy for such situations rests with the constitution or the legislature (or with bodies to which it delegates legislative authority) to define the purposes and the spheres of the institutions; with their charts before them, the institutions then undertake each its own voyage.

There is still another aspect to this unfortunate hostility between state institutions. It is the championship of the insti-

tution by alumni, in their organizations and elsewhere, and which may practically enforce the necessity of exterior regulation. The alumni loyalty is a fine spirit, much to be desired; but the first loyalty in the case of public-maintained institutions is to the state rather than to the college. The alumni attitude of the older eastern endowed colleges has been transferred bodily to state colleges, without discrimination and without realization of the fact that state relationships are involved. Herein lies one danger of alumni trustees in state institutions, although the alumni ought to make the best of advisers.

If we could get hold of the alumni bodies on the basis of good state policies rather than on the basis of blind partisanship, we should soon be able to solve most of our institutional conflicts, at the same time that we retain the needful support of the alumni of each one of them. We should then be free to make our institutions parts in a well-understood state program, and to allow each institution to work out most of its own problems. Undoubtedly some small duplications or perhaps even infringements would remain, but they would be devoid of hostility and have little power for evil, whereas the gains to come from free action would far outweigh any lack of conformity to an office or paper plan. It ought not to be difficult to make adjustments by means of conference if the underlying situation is properly established.

How to bring these alumni bodies to their senses is indeed a difficult problem. As these persons have been educated at state expense, so does the state have a right to ask service in return; and, if necessary, I should go so far as to give the alumni organizations legal standing and more or less state control. I feel, however, that the better result can be secured by processes of suasion. If a governor of a state, or the presidents of the institutions, or a few leading spirits in the alumni associations were to make an appeal along these lines, the whole situation would probably right itself in the course of a few years. It is more important first to appeal to the alumni than to the legislature. We are in too great haste to eliminate these difficulties. We must remember that these situations are the results of long-continued conditions; the difficulties are chronic and ingrained; so will it require time to work them out. We are to undo the mischief by gradually reversing or at least revising the process, not by a broadside of regulatory legislation.

All these foregoing statements indicate the drift of the time in the direction of over-administration, coupled with more or less hasty legislative enactments to meet special troubles. The remedy does not lie wholly, and perhaps not even chiefly, within the establishments themselves; in fact, routine tends to multiply, and to extol itself as desirable on its own account. Reformation is peculiarly the work of outsiders.

The course of our legislation in the field of education in agriculture shows a gradual federalizing of it, beginning with practically entire freedom in the original Land-Grant Act. In the new Smith-Lever Act the remedy—if a remedy is needed—does not lie within itself. Cooperation is not a remedy: it is an adjustment, a method of procedure, and it works only when all the parties agree. If the Land-Grant Act had been written and applied on the same principle, we could not have had our existing colleges of agriculture.

Another Kind of Agricultural Work

Well, then, where is the external influence to be maintained? Where is it to arise? Primarily in the suggestions of a free people. But its continuous practise must come from institutions.

There may be need, also, of a kind of agricultural work that can best be done in an institution that is independent of direct state support, and that is not at once responsible to popular will.

The fuller statement, from which this sentence is a quotation, is this:

The teaching of agriculture of college and university grade ought not to be confined to colleges of agriculture. All universities at least, on their own account and for their own best development, will in time have departments of agriculture, if they are real universities, as much as they have departments of language or of engineering. They can not neglect any fundamental branches of learning.[3]

At an earlier date, I had written:

It is strange that private benevolence has not discovered that the founding of schools of agriculture is one of the very best means of serving mankind.[4]

As these statements seem not always to have meant the same to others as I thought they meant to me, I shall now enlarge on them; and thereby shall I both explain myself and make my application.

My primary contention at the moment is that the agricultural and rural subjects may be made a means of education, used as so-called culture studies, and that a knowledge of them on the part of a large proportion of the people, in their general bearings, is essential to training for citizenship. They therefore become by right a part of the content of a school and of a college course. If any institution essays to cover the field of higher education, and is free to do so under the terms of its charter or of its state relations, then agriculture can not be omitted. Of course no institution should admit agriculture into its curriculum until it is ready for the subject and can provide the necessary support, any more than it should admit Greek or economics until it is ready for the subject. To be ready for agriculture requires much more than equipment and adequate funds: the institution, in its governing body and in its faculty, should come to the subject on the same educational basis as it comes to any other subject, prepared to give it opportunity and sympathetic consideration, and to make it in fact a worthy coordinate with other departments.

The agricultural work of which I here speak is to be a contribution to other courses and departments in a university. It might very well be a department in an arts course. Unfortunately, we think of agriculture in higher institutions of learning only as a very highly developed series of technical courses, maintained mostly on a semi-professional basis. This is properly the development in the land-grant colleges of agriculture; and in them, although the differentiation has gone very far, it will go still farther, for we must bring our rural situation up to its proper level. But in general and liberal-arts endowed universities, agriculture of another species may well be introduced, comparable with a department of a college rather than with a college entity itself. It need not provide "a course in agriculture," in the sense of a complete curriculum by itself, and it would not give a degree in agriculture. We can not expect all students desiring agriculture as part of a liberal education to matriculate in a college of agriculture.

The content of such teaching of agriculture would probably run strongly along the lines of the so-called humanities—along economics without being the customary economics, along civics without being the usual civics, along ethics without being speculative ethics, and always be founded on good sources of technical information touching the nature and processes of production, the values in rural life, knowledge of agricultural conditions, with frequent visits in rural communities and excursions

[3] "The Training of Farmers," p. 225, 1909.
[4] "The State and the Farmer," p. 166, 1908.

for special studies. Such an organization for agriculture would not need the extensive equipment of a college of agriculture, and not even a farm.

It will be observed that I speak of agriculture for endowed universities and colleges that are supposed to cover the field of liberal education. Whether agriculture of any kind should be taught in a state university in a commonwealth in which the land-grant college is separate, is a question of state policy. By the act of separating the institutions, the state practically sets boundaries to the university as well as to the land-grant college; it always remains, then, as I have already intimated, for the state itself, clearly to define the purposes and the functions. It is likewise a question of policy, internal in this case, as to whether even in a university carrying the land-grant work there should also be an arts course in agriculture.

I am convinced that we greatly need such departments of agriculture as are here suggested. The institutions need it on their own account, and we need it for the cause of education and to train our people for self-government. There is no such professorship of agriculture as this, so far as I know, in this country. The institutions are missing an opportunity.

My impression is that a first-class department of agriculture in a first-class university, with a living man at the head of it who has had naked-hand experience on the farm, would exercise a kind of influence in the subject and on the country that is now unvisioned, although much needed. I suspect that the judgment of such a department would have unusual weight with the public, being perhaps non-professional and free of propaganda and of governmental policies. I foresee students going from such teaching to the colleges of agriculture for more detailed and technical work; and I think I foresee certain students going to such a department for reflective graduate study and for the privilege of acquaintance with a teacher who is not buried in organization.

The old-time college professor, giving himself personally to his students, with few assistants, provided a type of leadership and of influence of the highest value; he lived the life; he was content in his work. To this man add something of the activity of the working world, but without administration of great schemes and without a maze of paralyzing reports, returns and projects, and you have your perfect teacher.

This teacher would be in position to maintain poise. He need not be afraid of deliberation. He would be greatly satisfied to watch the procession go by. We need a certain number of these men who are not only good students, but who are so detached from plans and managements that they can keep our philosophy straight.

THE CHECK PLOTS

We very well know that we need outside enterprises and influences to correct the tendencies of government. Education and research in agriculture are tied up with governmental procedure.

I would not have you think that I am opposed to governmental supervision. I do not even raise the question of the advisability or the merits of enactments or policies, although ready to review the tendencies in certain practises; and I wish distinctly to give my voice for the meeting of the laws to their full and in a whole-hearted way. Regard for law and authority is as much a safeguard of a free people as is the necessity for individual action. I am not implying that things are going bad with us, or that any of the agricultural enterprise is suffering. On the contrary, I think that our governmental work in agriculture

is on the whole particularly good. I know many of the men in this line of governmental oversight, and how capable they are. I know that we must have regularized procedure and good organization. It is said that for the greater number of persons close supervision is necessary, to which we all agree; and yet it is surprising how quickly these persons respond to leadership.

I know, on the other hand, that it is possible for governments, or methods suggested by governmental necessities, to invade educational work where they are not needed. I fear that the days of much freedom and spontaneity in the work are more behind us than ahead of us. We naturally extend a method or a way of procedure throughout a system, as if uniformity were in itself an asset. The very expansiveness of the enterprises, the extent of funds involved, the vast size of the country, the numbers of students, the alertness of the people for solutions, all demand a complex method of administration and tend to immerse a man in the system. I do not see how it can be avoided. All the more is the necessity, therefore, for opportunities to those persons who wish to do a personal work and to express themselves—just themselves—in the doing it. All the more do we need the example of institutions which have policies wholly their own, to safeguard any future danger of too much regulation in the governmental side. One set would prove a powerful stimulus to the other as well as to exercise a natural control. I hope there will never be any need of outside suggestion to restrain persons in the public institutions who aspire to be governors, congressmen, and the like, who may be tempted to use their opportunities to that end, and who are thereby out of place in college and science work.

As the public work becomes more crystallized and more official, as is of course inevitable, the colleges of agriculture will begin to lose their boldest men. We know that many men in government like to escape to institutions, as to universities: will they desire also, in time, to escape the institutions?

You must not think that I am here summoning the bogy-man of "politics," as a discouragement to institutions supported by the state. Quite the contrary: I have seen something of institutions; I fear the entrance of "politics" as much into the governance of other institutions as of state institutions, and perhaps even more so, seeing that it is not answerable to public correction. We are moving rather rapidly in these days away from star-chamber deals and partizan control and upheavals. But there remains the more dangerous because the more insidious formalizing of the daily work, regulating of hours, deadly conforming of editorial offices, employing of too many clerks and intermediaries, the gradual tying of the hands without any intention whatever that it shall be so, the piling up of paper duties. That is to say, the old-time fear of politics has now been superseded by the actual danger of impersonal interference in details and of machine routine. I am not so much afraid of "politics" as I am of the dead-levels.

The old separatism in agriculture is breaking up. The human forces are reshaping. New crystallizations are taking place before our eyes, rapidly. Many plans of cooperation and co-action, small and large, are much recommended. Now is the time to be careful that our rural life shall not be machine-made and over-organized.

THE FIELD FOR PRIVATE FOUNDATIONS

The land-grant colleges of agriculture are not to expect to hold exclusively the entire field of agriculture-education of the

higher grade, nor is it desirable that they should do so. They do not necessarily represent the last word in this field of public service. We must soon begin to think of another range.

Private philanthropy will find this inviting and useful field. Universities of many kinds will enter it as of their own domain. The land-grant institutions will not lose their influence and standing: on the contrary, they ought to begin to produce the leaders for the other development, and specially must they be prepared to accept the other institutions, when those institutions are really ready and worthy, and give them encouragement; and in particular must they not sit as censors.

These new developments being foreseen and I think inevitable, then a *modus vivendi* must be found in advance. The first desirability, as I have suggested, is an attitude of encouragement for all good effort in teaching and research; the next essential is a willingness on the part of the land-grant institutions to divide the field, or at least to share it, so far as they can do so and not surrender their legal or necessary rights or curtail their usefulness. No one would want these institutions restricted; in fact, this must not be, since they have been set aside to do a great work in a democracy.

The other institutions, those not teaching agriculture on the land-grant basis, should recognize that the public-maintained colleges are now established in their field, that this field belongs to them by law, that these colleges are doing their work nobly, and that the people will resent interference; and they must remember the fine disdain in which the colleges of agriculture have been held in times past. These other institutions should not attempt to duplicate the work and equipment of the land-grant colleges; they should enter fields of their own. The effort to secure state support for such institutions is a perversion; it introduces the very element of competition and conflict that it is so necessary to avoid, and the institutions also thereby lose their special opportunity. Neither will these institutions, if they are wise, enter the field to secure advertisement for any university or any body, counting on the rising interest in agriculture; the land-grant colleges are fortunately too strong for such a purpose to gain much headway.

What these fields are, for the non-land-grant endowed institutions, may not be easy to forecast in detail; but if the institutions desire to find such a field, the danger of duplication, conflict and hostility will thereby be avoided. In fact, these other institutions can never acquire the place they ought to find and which they have a right to enter, by any movement of attack or of imitation. The example of the untrammeled spirit, which they ought to contribute to governmental enterprises, must of course be born in freedom and in great good will.

Already have we discussed the opportunity in a liberal-arts college or in a university for a department of agriculture. We may now consider what an endowed institution, established separately in the agricultural field, including horticulture, forestry, and other rural work, may undertake. There is opportunity and need in abundance in the training-school field, but we are not now considering this range. In the college and university range, it is probably not worth the while to undertake a new effort "to make farmers," although this particular fallacy seems to be very attractive to many men.

1. If the hypothetical institution is to engage in research, it had better not attempt to cover the field of agriculture, as the colleges of agriculture are obliged to cover it in order to answer the needs of the commonwealth; it had better confine itself to a problem or a set of closely related

problems, organizing carefully for the effort, equipping to the highest, securing the best investigators regardless of the salary cost and allowing them to give themselves unreservedly to the research, without extension work or propaganda. This kind of intensive investigation, long-continued, patiently pursued, not depending for support on popular will, not interfered with by endless extraneous records and reports of progress, not obliged to demonstrate the necessity for its existence, would have a far-reaching influence for good.

2. If the institution is designed only to enter extension work in agriculture, it had better cease before it begins. The public forces are already at the command of the national cooperative extension enterprises; these enterprises are founded on good investigational work and on the accumulation of experience in the regularly established institutions. Extension work should never be projected *in vacuo*.

3. If it is in teaching of the higher grade that the new separate institution would express itself, then it must find its place, if at all, by sheer commanding excellence. It will compete first of all with the land-grant college of its own state, if it is of comparable grade, and with similar institutions in forty-seven other states, not to mention those in the provinces of Canada; this will present at once a difficult situation. If it is of inferior grade, then it must recognize its place and not attempt to give a degree in agriculture, or otherwise to bring the educational standards in this new field, now being attained with much hard effort, into disrepute. I can imagine a very worthy private foundation on college and even on university grade, making its way continuously and successfully, but I should expect it to make best headway if it specialized rather than attempted to cover the whole field; the expense in staff and equipment to occupy the entire field would be very heavy, and it is doubtful whether the extra expenditure, at this epoch, would be socially justifiable. This particular complete range or organization of college teaching seems to be peculiarly the province of the state to support; and the state is already deeply engaged in the enterprise. By combining good agricultural work of a restricted kind with other nature-work, not eliminating other cultural studies, an endowed institution could make for itself a very useful place.

4. Long have I felt that a new kind of institution for agriculture, of very high grade, will some day arise on private endowment. This will be a coordinating and leadership institution, teaching advanced and special students in some subjects, engaging in research, but in the main making its contribution as a place for conference, for consideration of the large civic and social relations of rural life, and as a voluntary meeting-place on common and neutral ground for all the forces that lie in the situation. The state colleges of agriculture are coordinate with each other, they draw support from the same classes of funds, they come to have a comity of equality, they are all restricted in their outlook or at least in their practise by their necessary connections. We may be sure that there are bounds beyond which they may not go in making opinion on certain lines of great public questions. Government can not lead them: it can only supervise and regulate them.

I think I see the necessity for better opportunities than the land-grant or other state-maintained institutions are likely to give the freest men. Where shall we place our prophets? Separately they may accomplish much, but backed by facilities and a broad institution they may accomplish much more. One institution founded with

sympathy and on statesmanship could occupy a great place, if any board of governors were wise enough to avoid the cranks. It certainly would avoid all red-tape and all routine-men and all perplexing alliances. We may well look to government to coordinate the fiscal business and to some extent the projects of the public institutions, but we can not expect it to bring together the spiritual elements that alone can make a movement or a people great. Spiritual forces are always spontaneous.

I want to see at least one broad foundation, separately placed, certainly not in Washington, highly endowed, that will attract the best spirits somewhat independently of the subjects that they teach, to enable these men and women to give of themselves in a composite faculty, and to represent the best leadership in statecraft and other subjects as related to agriculture and country life. We are so accustomed to the formally regular program of the existing college of agriculture that an outline like this may seem to be indefinite and to lack cohesion, but it is not so very different from the old idea of a university; in fact, it might be known as a university founded on the earth, on rural life, with its students mostly graduates and not very numerous, with a good nature-background and not top-heavy with technical equipment.

THE CONCLUSION OF THE WHOLE MATTER

My presentation is of four motives: (1) To extend the rural teaching, founded on agriculture, into general and liberal arts institutions, to the end that it may be made a means of culture, a force for training in citizenship, and a broadening influence in the institutions; (2) to indicate a way in which private endowments or enterprises of college and university grade may be hopefully made in agriculture; (3) to suggest the need of non-governmental movements which shall introduce into this field the same balance and counter-balance of forces that is essential in other fields for the maintenance of government that arises from the people, for not even in a democracy should all education be state-maintained; (4) to conserve the independence and the opportunities of the boldest prophets.

Of these motives, the last one I consider to be much the most important, the necessity to provide a footing for at least a few men without official attachments, of superior qualifications, and with an outlook covering the entire field.

The historian will discover this present segment of time to have been remarkable for its attainments with the products in agriculture. It is an epoch of wonderful horses, record-breaking cows, magnificent bulls, impeccable fowls; an epoch of marvellous fruits of the land, and of vast projects of reclamation. But the temper of the time begins to run out to the human factors, to the worth of the people in all the localities, to the little movements here and there that arise like springs in a fertile field. We just begin to glimpse something beyond us, as yet undefined; and presently our thought will begin to run backward to discover who were the men far in the generations behind us who saw something of this field and what they said about it, and what have been the rills of influence that have made the present current. We shall look forward for leaders, and shall discover that although we have had major prophets, not yet have we had a national figure.

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Such questions as these that we have raised, and many more of wide reach, must be discussed somewhere before representative gatherings. Shall it be here or elsewhere? This company comprises members of the Association and adherents of Section

M. What shall be the field and the function of this body? Shall it be strictly professional and official? Or shall it represent our democratic spirit and our forecast, introducing the element of public policy and prophecy even into technical discussion, bringing together the men and women from all sides and expressing all the work and movements? Our work is well under way. The morning hours are passed and the day is well toward noon.

L. H. BAILEY

UNIVERSITY REGISTRATION STATISTICS

THE registration returns for November 1, 1915, of thirty of the universities of the country will be found tabulated on a following page. These statistics show only the registration in the universities considered. There is no intention to convey the idea that these universities are the thirty largest universities in the country, nor that they are necessarily the leading institutions.

The largest gains in terms of student units, including the summer attendance, but making due allowance by deduction for the summer session students who returned for instruction in the fall, are registered by California (2,375), Pennsylvania (900), Minnesota (892), Chicago (837), Columbia (594), and Pittsburgh (594), New York University (514), Ohio State (508), Illinois (486), Missouri (483), Cornell (412), Iowa State (370), Michigan (365), Northwestern (336), Cincinnati (334), Western Reserve (302).

The University of California shows a large gain of 2,375 students; no other institution shows a gain of more than 1,000 as against four last year. However, sixteen institutions (listed above) show gains of more than 300 as against fourteen last year and ten the year before. The fourteen institutions last year were Columbia, California, Pittsburgh, Ohio State, Wisconsin, Harvard, New York University, Minnesota, Pennsylvania, Illinois, Nebraska, Cornell, Cincinnati, and Michigan. Of these Wisconsin, Harvard and Nebraska are not included this year in the group, and Chicago, Missouri, Iowa State, Northwestern, and Western Reserve are included this year but were not last year.

Four institutions as against one last year show decreases in grand total attendance. They are Tulane, Washington University, Harvard and Princeton. Exclusive of summer sessions Western Reserve and Wisconsin show decreases, Washington University and Princeton not having summer sessions.

Omitting the enrollments in the summer session, the universities showing the largest gains for 1915 are Pennsylvania (916), Minnesota (739), Pittsburgh (594), Ohio State (502), New York University (438), Chicago (437), Illinois (374), California (363), Missouri (361), Cincinnati (334), Cornell (314), Michigan (299), Columbia (290), Nebraska (288), Harvard (274), Iowa State (255), Northwestern (208), Indiana (201). Eighteen show gains of more than 200 as against fourteen last year and twelve the year before last. Of the eighteen thirteen are in the west and far west and five are in the east. A similar list last year consisted of eight western and six eastern institutions.

According to the enrollment figures for 1915, the thirty institutions, inclusive of the summer sessions, rank as follows: Columbia (11,888), California (10,555), Chicago (7,968), Pennsylvania (7,404), Wisconsin (6,810), Michigan (6,684), New York University (6,656), Harvard (6,351), Cornell (6,351), Illinois (6,150), Ohio State (5,451), Minnesota (5,376), Northwestern (4,408), Syracuse (4,012), Missouri (3,868), Texas (3,572), Pittsburgh (3,569), Nebraska (3,356), Yale (3,303), Iowa State (3,138), Kansas (2,806), Cincinnati (2,524), Indiana (2,347), Tulane (2,160), Stanford (2,061), Western Reserve (1,825), Princeton (1,615), Johns Hopkins (1,586), Washington University (1,264), Virginia (1,008).

A comparison shows that the following eighteen universities hold the same relative positions (indicated by the numerals following the name) as was held last year. Columbia (1), California (2), Chicago (3), Cornell (9),

Illinois (10), Ohio State (11), Minnesota (12), Northwestern (13), Syracuse (14), Missouri (15), Texas (16), Nebraska (18), Iowa State (20), Kansas (21), Stanford (25), John Hopkins (28), Washington University (29), and Virginia (30). The other twelve institutions shift about as follows: Pennsylvania advances to fourth position, forcing Wisconsin back to fifth. Harvard, holding sixth position last year, falls back to the eighth, and Michigan and New York move up a notch. Pittsburgh formerly nineteenth, exchanges with Yale for the seventeenth position and Tulane drops back two places, thus advancing Cincinnati and Indiana. Western Reserve and Princeton change about.

If the summer session enrollment be omitted the universities in the table rank in size as follows: Columbia (7,042), Pennsylvania (6,655), California (5,977), New York University (5,853), Michigan (5,821), Illinois (5,511), Harvard (5,435), Cornell (5,392), Ohio State (4,897), Wisconsin (4,868), Minnesota (4,679), Chicago (4,324), Northwestern (4,153), Syracuse (3,830), Pittsburgh (3,569), Yale (3,303), Nebraska (3,067), Missouri (3,043), Iowa State (2,704), Texas (2,611), Cincinnati (2,524), Kansas (2,470), Stanford (2,048), Indiana (1,771), Princeton (1,615), Western Reserve (1,469), Tulane (1,321), Washington University (1,264), Johns Hopkins (1,173), Virginia (1,008).

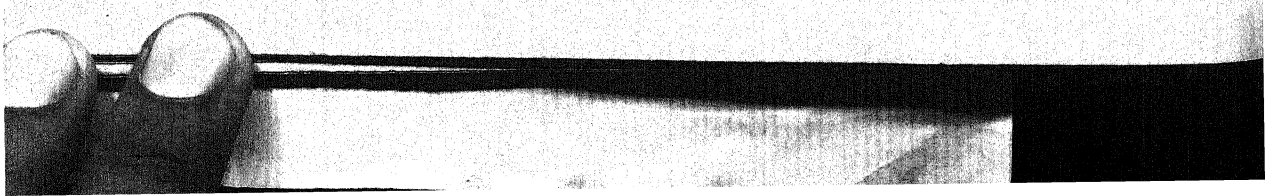
A comparison shows that the relative positions of thirteen of the universities remain unchanged, and that the changes in the position of the remaining seventeen institutions involve only the shifting about of pairs—except in one instance. These shifts include the following, the first in each case having the advantage. New York and Michigan, Illinois and Harvard, Ohio State and Wisconsin, Pittsburgh and Yale, Cincinnati and Kansas, Indiana and Princeton, and Tulane and Washington. Northwestern is now thirteenth, Minnesota and Chicago advancing a step thereby.

Including the summer sessions the largest gains in the decade from 1905 to 1915 were made by Columbia (7,133), California (6,924), Pennsylvania (3,873), New York University (3,744) Wisconsin (3,727), Chicago (3,411), Ohio State (3,394), Illinois (2,515), Cornell (2,480), Texas (2,382), Michigan (2,163). The same group made the largest gains in the decade 1904 to 1914. Considering the gains in the last ten years of the thirty institutions, it is of interest to note that although the state institutions have had wide public attention because of their phenomenal growth a study shows that the other institutions of the group have also made noteworthy advances, approximately equalling in the aggregate the growth of the state universities.

Considering now the individual schools of the various universities, in the number of college undergraduates, California leads with 1,294 men and 2,023 women, followed by Harvard with 2,516 men and 653 women (Radcliffe College); Michigan with 1,986 men and 890 women; Minnesota with 993 men and 1,074 women; Chicago with 1,161 men and 851 women; Wisconsin with 850 men and 970 women; Columbia with 1,118 men and 656 women; Nebraska with 780 men and 826 women; Texas with 835 men and 767 women; Kansas with 873 men and 678 women; Iowa with 741 men and 762 women; Yale with 1,489 men; Indiana with 837 men and 597 women; Syracuse with 1,430 men and women; Missouri with 792 men and 588 women; Northwestern with 645 men and 711 women; Princeton with 1,306 men; Ohio State with 853 and 430 women; Stanford with 820 men and 401 women.

In engineering, Michigan now leads with 1,498 students followed by Cornell with 1,347, Illinois with 1,148, Yale with 1,039, Ohio State with 841, Wisconsin with 758, California with 712, Pennsylvania with 611, Minnesota with 578, Missouri with 564, Cincinnati with 474, and Stanford with 434. In law, Harvard holds the lead with 786 students, New York University with 726, Columbia with 471, Michigan with 431, Texas with 340, and Northwestern with 314 following in order.

The largest medical school is at New York University, where 509 students are now enrolled. Michigan has 378 students registered in medicine; California, 373; Johns Hopkins,



371; Tulane, 350; Harvard, 340; Pennsylvania, 340; Minnesota, 258; Northwestern, 238; Illinois, 226; Ohio State, 222; Texas, 216; and Chicago, 200. The non-professional graduate school of Columbia with 2,065 students is by far the largest. Chicago follows with 617; then Harvard with 587, California with 560, Pennsylvania with 548, Illinois with 403, Cornell with 395, New York University and Yale with 348 each, and Wisconsin with 322. Cornell continues to hold the lead in agriculture, with 1,608 students, followed by Illinois with 1,067, Wisconsin with 972, Ohio State with 970, Minnesota with 648, California with 581, Missouri with 560 and Nebraska with 512. The three universities reporting courses in architecture are Pennsylvania with 254 students, Illinois with 167, and Cornell with 166. The students in other institutions registered in architecture are listed in other schools of their respective universities. Washington University with 188 students leads in art, followed by Syracuse with 182, Nebraska with 65, Tulane with 61, Yale with 47, and Indiana with 43.

The school of commerce of New York University has 2,639 students. Pennsylvania's school follows with 1889 students, Pittsburgh's with 916, Northwestern's with 741, Wisconsin's with 542, Illinois' with 527, and California's with 308. Pennsylvania leads in dentistry with 744, followed by Northwestern with 666, Minnesota with 373, Michigan with 351, Iowa State with 303, Pittsburgh with 259, Harvard with 234. Of the four universities reporting schools of divinity, Northwestern has the largest with 196 students as against Chicago's 137, Yale's 105, and Harvard's 72.

The school of education at Columbia numbers this year 1,972 students as compared with 897 at Pittsburgh, 514 at Ohio State, 451 at Texas, 445 at New York University, 432 at Indiana, 413 at Cincinnati, 390 at Syracuse, and 352 at Chicago.

In forestry Syracuse leads with 292; then comes Ohio State with 44, Minnesota with 41, Yale 32 and Harvard with 4. New York University has the largest school of journalism with 151 students. Columbia follows with 143, Wisconsin with 116, Missouri with 94, Indiana with 75, and Texas with 46. With 86 students, Syracuse leads in library economy, followed by Illinois with 39, Wisconsin with 34, Western Reserve with 27, Iowa State with 20, and Indiana with 7. Syracuse also leads in music with 836 students enrolled. Northwestern reports 326, Kansas 110 and Texas 109. The pharmacy school of Columbia numbers 462. The next largest school is at Pittsburgh, where 240 are enrolled; then comes Illinois with 195, Western Reserve with 120, and Michigan with 114. The course in veterinary medicine at Ohio State numbers 160, at Cornell 145, and at Pennsylvania 144.

All of the above figures are for individual schools and colleges and are exclusive of the summer-session attendance. The largest summer-session in 1915 was at Columbia, where 5,961 students were enrolled. At California a phenomenal increase of 2,012 brought the enrollment of their summer-session to 5,364. Attendance at the summer-session of the University of Chicago was 4,369, at Wisconsin 2,780, at Michigan 1,677, at Cornell 1,509, at Texas 1,265, at Minnesota 1,141, at Missouri 1,135, at Pennsylvania 1,065, at New York 1,063, at Tulane 1,037, at Ohio State 1,029, and at Illinois 1,028.

The following paragraphs are explanatory of statistics appearing herewith with some additional information.

A study of the student enrollment in the scientific schools of mines, engineering and agriculture at Columbia University shows a steady decrease in enrollment corresponding to a steady increase of admission requirements now based upon a collegiate course of at least three years.

It is interesting to note that of the 1,608 students of agriculture at Cornell, 290 are women. There are seven women enrolled in the law school of that University, twenty-one in medicine, three in architecture, and one in mechanical engineering.

At the University of Cincinnati two years of college work has been added as a prerequisite for entrance to the school of household arts. This has resulted in a decrease of 42

	California	Chicago	Cincinnati	Columbia	Cornell	Harvard (Inc. Radcliffe)	Illinois	Indiana	Iowa State	Johns Hopkins	Kansas	Michigan
College, Men	1294	1161	315	1118	1007	2516	599	833	741	321	863	1986
College, Women	2023	851	543	656	341	653	520	597	762	.....	678	890
Scientific Schools[1]	712	.....	474	341	1347	10	1148	389	245	.....	386	1498
Law	158	235	.....	471	234	786	86	98	153	.....	166	431
Medicine	116	200	92	373	170	340	226	151	164	371	128	378
Non-professional graduate Schools	560	617	139	2065	395	587	403	92	158	239	108	267
Agriculture	581	.....	.....	.....	1608	.....	1067	.....	94	.....	.....	.....
Architecture	14	.....	.....	87	166	54	167	18	.....	.....	27	[3]
Art[2]	[3]	.....	9	.....	.....	.....	[3]	43	19	.....	19	.....
Commerce	308	.....	196	.....	.....	179	527	116	100	.....	.....	[3]
Dentistry	141	.....	.....	.....	.....	234	127	.....	303	.....	.....	351
Divinity	.....	137	.....	.....	.....	72	.....	.....	.....	.....	.....	.....
Education	[3]	352	413	1972	.....	.....	[3]	432	262	.....	197	[3]
Forestry	.....	.....	.....	.....	.....	4	[3]	.....	.....	.....	.....	[3]
Journalism	.....	.....	.....	143	.....	.....	[3]	75	16	.....	.....	[3]
Library Economy	.....	.....	.....	.....	.....	.....	39	7	20	.....	.....	[3]
Music	[3]	.....	.....	.....	.....	.....	59	77	80	.....	110	.....
Pharmacy	93	.....	.....	462	.....	.....	195	.....	72	.....	54	114
Veterinary Medicine	[3]	.....	.....	.....	145	.....	.....	.....	.....	.....	.....	.....
Other Courses	.....	1020	749	.....	.....	.....	349	.....	96	286	.....	.....
Deduct Double Registration	23	249	406	646	21	.....	1	1157	581	42	266	94
Total	5977	4324	2524	7042	5392	5435	5511	1771	2704	1173	2470	5821
Summer Session 1915	5364	4369	.....	5961	1509	916	1028	861	668	487	569	1677
Deduct Double Registration	786	725	.....	1115	550	.....	389	285	70	74	233	814
Grand Total 1915	10555	7968	2524	11888	6351	6351	6150	2347	3138	1586	2806	6684
Grand Total 1914	8180	7131	2190	11294	5939	6411	5664	2163	2768	1374	2650	6319
Grand Total 1912	6457	6351	1924	9002	5412	5729	4315	2192	1944	1058	2403	5620
Grand Total 1910	4552	5883	1416	7411	5169	5329	4659	2132	1957	890	2246	5339
Grand Total 1905	3631	4557	.....	4755	3871	5283	3635	1377	1700	688	1706	4521
Extension and Similar Courses	6859	.....	322	4606	549	1300	.....	339	16	.....	725	350
Officers and Instructional Staff	587	315	300	995	.....	.....	657	202	298	.....	218	565

[1] Includes Schools of Mines, Engineering, Chemistry and related subjects.

students. On the other hand the colleges of the university have shown a gratifying increase.

The decrease in registration at the University of Illinois, as in the case of other schools, is due to increased entrance requirements. Generally speaking, a decrease is almost certain when entrance requirements or tuition are increased. An increase in students following such action is the exception.

Connected with its college of liberal arts, the State University of Iowa has a department of graphic and plastic arts on the same basis as the departments of Latin, Greek, mathematics, etc., and courses in this department are offered toward a bachelor's degree. The school of music, by state action, has been made a department of the college, but not all of the courses are accepted toward a bachelor's degree. The course in journalism, the college of education and the school of commerce are in fact departments of the college of liberal arts. These have no separate faculty organization apart from the organization of the faculty of the college of liberal arts.

At Johns Hopkins University, large increases are noticeable in the "College Courses for Teachers" and in the junior courses. The reasons may be summarized as follows: The university has established the degree of Bachelor of Science in Education, and has opened the courses to students enrolled in other departments. The increase in the Summer Courses is due; first, to the addition, for the

Minnesota	Missouri	Nebraska	New York University	Northwestern	Ohio State	Pennsylvania	Pittsburgh	Princeton	Stanford	Syracuse	Texas	Tulane	Virginia	Washington University	Western Reserve	Wisconsin	Yale
993	792	780	597	645	853	{528	439	1306	820	1430	835	239	522	201	418	850	1489
1074	588	826	242	711	430		165	.....	401		767	226	.....	271	440	970	.....
578	564	317	270	98	841	611	314	134	434	285	283	136	114	171	.....	758	1039
165	118	153	726	314	163	254	180	.....	173	260	340	77	236	134	109	175	117
258	94	118	509	238	222	340	129	.....	85	114	216	350	112	105	180	98	59
220	154	234	348	114	192	548	121	175	148	140	71	11	45	69	30	322	348
648	560	512	.....	.....	970	.....	.....	.....	.....	144	35	.....	.....	.....	.....	972	.....
76	.....	.....	.....	.....	90	254	.....	.....	.....	54	51	21	.....	33	.....	.....	.....
.....	.....	65	.....	.....	.....	.....	.....	.....	.....	182	.....	61	.....	188	.....	.....	47
.....	14	236	2639	741	.....	1889	916	.....	.....	.....	97	169	.....	.....	.....	542	.....
373	.....	75	.....	666	160	744	259	.....	.....	.....	.....	69	.....	140	187	.....	.....
.....	.....	.....	.....	196	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	105
88	285	255	445	.....	514	225	897	.....	.....	390	451	90	.....	.....	.....	39	.....
41	[3]	.....	.....	.....	44	.....	.....	.....	.....	292	.....	.....	.....	.....	.....	.....	32
.....	94	.....	151	.....	.....	.....	.....	.....	.....	.....	46	8	.....	.....	.....	116	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	86	.....	.....	.....	.....	27	34	.....
73	.....	.....	.....	326	.....	27	.....	.....	.....	836	109	29	.....	.....	.....	82	98
99	.....	52	.....	71	94	.....	240	.....	.....	.....	52	13	.....	.....	120	36	.....
.....	.....	.....	26	.....	160	144	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	276	263	1091	.....	.....	.....	93	140	.....	.....	.....	.....	1	.....
29	22[illegible]	556	100	243	99	.....	91	.....	13	476	882	178	21	48	42	127	31
4679	3043	3067	5853	4153	4897	6655	3569	1615	2048	3830	2611	1321	1008	1264	1469	4868	3303
1141	1135	610	1063	359	1029	1065	.....	.....	77	311	1265	1037	.....	.....	361	2780	.....
444	310	321	260	104	475	316	.....	.....	64	129	304	198	.....	.....	5	838	.....
5376	3868	3356	6656	4408	5451	7404	3569	1615	2061	4012	3572	2160	1008	1264	1825	6810	3303
4484	3385	3199	6142	4072	4943	6504	2975	1641	1893	3913	3371	2441	902	1345	1523	6696	3289
3737	2871	2811	4543	3632	3608	5287	1883	1568	1670	3529	3016	2249	799	958	1378	5141	3265
4972	2678	2733	3947	3543	3181	5187	.....	1451	1648	3248	2597	1985	688	796	1274	4745	3287
3940	1887	2635	2912	2791	2057	3430	.....	1361	1606	2776	1190	838	696	.....	856	3083	3477
1044	256	907	1732	.....	.....	665	500	.....	.....	.....	1186	105	.....	607	222	3798	.....
.....	302	506	490	480	481	600	395	232	363	315	237	342	112	218	261	685	616

[2] Includes painting and sculpturing.

[3] Included elsewhere.

first time, of graduate courses, for which credit may be secured towards the fulfillment of the requirements for the degree of Master of Arts; second, to the accrediting of the summer college courses toward the Bachelor of Science in Education degree (referred to above); third, to the establishment of a state law requiring attendance by state teachers upon a junior school; and fourth, to the permissible substitution of summer courses for attendance upon teachers' institutes.

The University of Michigan law school shows a loss of about fifty students due to a new requirement of two years of collegiate work for admission in place of the one year requirement which had been in force the previous three years. In the college of literature, science and the arts the gain was unexpected; the gain in women students being probably due to the opening of two new residences for women.

Part of the increase in the college of science, literature and the arts at the University of Minnesota is the result of an announcement of special courses arranged for the Twin City teachers which met with a gratifying response. The large increase in the college of dentistry is due to a dual freshmen enrollment, the last in the three-year course, and the first in a four-year course established this year. The maximum number of students were admitted to the freshmen class in the three-year course and

ninety students were admitted to the first-year class in the four-year course.

The large increase in registration in the scientific schools in the University of Missouri is due to the fact that beginning with the present year the school of engineering admits high-school graduates instead of requiring two years of college work for admission. No change has been made in the actual time required for securing the degree in engineering, but the first two years of the curriculum are now given in the school of engineering instead of in the college of liberal arts, resulting in a corresponding decrease, however, in the number of men in college. The professional schools show an increase, but the largest increase is in the school of education, due chiefly to the growing number of graduates of normal schools and colleges who continue their work in the university. A part of the development of the university in recent years has been due to a system of accredited junior colleges throughout the state.

The 645 men at the college of liberal arts of Northwestern University include 90 students in engineering who are registered for the bachelor's degree, and a small group of pre-legal students who are taking their first year's work in Evanston. Although the total number of students in the school of music shows a decrease, the enrollment of full time students is larger than last year.

The increase in entrance requirements to the professional colleges of law and medicine at Ohio State University naturally brought a loss in number, but this is also a part of the cause of a large increase in the college of liberal arts. The college of medicine now requires two years of academic work for admission, and has increased its curriculum from three to four years.

The summer school of the University of Virginia is conducted apart from the regular university session although credit is given by the university for certain work done. The summer school is one of several conducted in different parts of the state and had an enrollment in 1915 of 1,325.

The new summer school at Western Reserve opened with an enrollment of 361 students. The courses for teachers almost doubled in registrations over last year. The visiting nurses' class has five, and the course in advertising twenty-one.

The increase in the school of fine arts and music at Yale is probably due to conditions abroad which prevent students going to Paris, Berlin and other art centers. Although the total registration in the graduate school is less than last year, the number of candidates for the degree of master of arts and of doctor of philosophy is slightly increased.

John C. Burg
Northwestern University

ACADEMIC FREEDOM AND ACADEMIC TENURE

The committee on academic freedom and academic tenure of the American Association of University Professors, of which Professor E. R. A. Seligman, of Columbia University, is chairman, presented its report at the annual meeting on January 1. The first part of the report (printed in *School and Society*) is a general declaration of principles, some twenty pages in length; the second part consists of practical proposals which are as follows:

As the foregoing declaration implies, the ends to be accomplished are chiefly three:

First: To safeguard freedom of inquiry and of teaching against both covert and overt attacks, by providing suitable judicial bodies, composed of members of the academic profession, which may be called into action before university teachers are dismissed or disciplined, and may determine in what cases the question of academic freedom is actually involved.

Second: By the same means, to protect college executives and governing boards against unjust charges of infringement of academic freedom, or of arbitrary and dictatorial conduct—charges which, when they gain wide currency and belief, are highly detrimental to the good repute and the influence of universities.

Third: To render the profession more attractive to men of high ability and strong personality by insuring the dignity, the independence and the reasonable security of tenure, of the professorial office.

The measures which it is believed to be necessary for our universities to adopt to realize these ends—measures which have already been adopted in part by some institutions—are four:

A. *Action by Faculty Committees on Reappointments.*—Official action relating to reappointments and refusals of reappointment should be taken only with the advice and consent of some board or committee representative of the faculty. Your committee does not desire to make at this time any suggestion as to the manner of selection of such boards.

B. *Definition of Tenure of Office.*—In every institution there should be an unequivocal understanding as to the term of each appointment; and the tenure of professorships and associate professorships, and of all positions above the grade of instructor after ten years of service, should be permanent (subject to the provisions hereinafter given for removal upon charges). In those state universities which are legally incapable of making contracts for more than a limited period, the governing boards should announce their policy with respect to the presumption of reappointment in several classes of position, and such announcements, though not legally enforceable, should be regarded as morally binding. No university teacher of any rank should, except in cases of grave moral delinquency, receive notice of dismissal or of refusal of reappointment, later than three months before the close of any academic year, and in the case of teachers above the grade of instructor, one year's notice should be given.

C. *Formulation of Grounds for Dismissal.*—In every institution the grounds which will be regarded as justifying the dismissal of members of the faculty should be formulated with reasonable definiteness; and in the case of institutions which impose upon their faculties doctrinal standards of a sectarian or partisan character, these standards should be clearly defined and the body or individual having authority to interpret them, in case of controversy, should be designated. Your committee does not think it best at this time to attempt to enumerate the legitimate grounds for dismissal, believing it to be preferable that individual institutions should take the initiative in this.

D. *Judicial Hearings Before Dismissal.*—Every university or college teacher should be entitled, before dismissal[1] or demotion, to have the charges against him stated in writing in specific terms and to have a fair trial on those charges before a special or permanent judicial committee chosen by the faculty senate or council, or by the faculty at large. At such trial the teacher accused should have full opportunity to present evidence, and, if the charge is one of professional incompetency, a formal report upon his work should be first made in writing by the teachers of his own department and of cognate departments in the university, and, if the teacher concerned so desire, by a committee of his fellow specialists from other institutions, appointed by some competent authority.

[1] This does not refer to refusals of reappointment at the expiration of the terms of office of teachers below the rank of associate professor. All such questions of reappointment should, as above provided, be acted upon by a faculty committee.

SCIENTIFIC NOTES AND NEWS

AT the meeting of the Society of American Bacteriologists held at the University of Illinois at the end of December, Dr. Thomas J. Burrill, formerly vice-president of the university, was elected president of the society for the coming year.

DR. A. O. LOVEJOY, of the Johns Hopkins University, was elected president of the American Philosophical Association at the meeting held recently in Philadelphia.

DEAN FREDERICK J. WULLING, of the college of pharmacy of the University of Minnesota, has been elected president of the American Pharmaceutical Association.

AT the annual meeting of the Cosmos Club, Washington, D. C., on January 10, Dr. Hugh M. Smith, U. S. commissioner of fisheries, was elected president for the year 1916.

SIR ARCHIBALD GEIKIE, the distinguished geologist, celebrated his eightieth birthday on December 28.

THE ministry of public instruction of the French government has selected Dr. Wallace Clement Sabine, Hollis professor of mathematics and natural philosophy at Harvard University, as exchange professor with France for 1916–17. His term of service will fall in the winter semester and will be spent at the University of Paris.

DR. O. VAN DER STRICHT, professor of histology and embryology, University of Ghent, Belgium, has arrived from Holland to accept

the post of fellow in cytology in the medical school, Western Reserve University. Professor Van der Stricht will devote his time to research.

The Perkin medal of the Society of Chemical Industry will be presented to Dr. L. H. Baekeland on the evening of January 21 at a meeting held at Rumford Hall, the Chemists' Club, New York City. The address of presentation will be made by Dr. Charles F. Chandler, senior American past-president of the Society of Chemical Industry.

At the fifteenth annual meeting of the American Philosophical Association held at the University of Pennsylvania on December 28, 29 and 30, in honor of Professor Josiah Royce, of Harvard University, and, in celebration of his sixtieth birthday, the afternoon session on Tuesday and morning session of Wednesday were devoted to the reading and discussion of papers on his philosophy. The speakers at these sessions were Drs. John Dewey, H. H. Horne, R. C. Cabot, J. W. Hudson, M. W. Calkins, E. G. Spaulding, W. H. Sheldon, E. E. Southard and C. M. Bakewell. At the annual banquet on Wednesday evening the guest of honor was Professor Royce, who made the only address.

At the two hundred and ninety-first regular meeting of the Entomological Society of Washington the constitution was amended so as to permit the election of an honorary president, such office to be tendered only to active members who have been especially prominent in the affairs of the society and to convey with it expressions of gratitude, respect and honor. After creating this office, the society elected unanimously Mr. E. A. Schwarz as first honorary president. Mr. Schwarz was one of the charter members of the society, has held the office of president for two terms, vice-president for a number of terms and secretary for a number of terms and has taken an active interest in the affairs of the society. He has attended every meeting of the society when he has been in Washington, has contributed greatly to its financial support and has entertained the society more than any other member. He is an internationally recognized authority on Coleoptera and has contributed materially to the advancement of his favorite group and also to the general science of entomology.

At the seventh annual meeting of the American Phytopathological Society, held at Columbus, Ohio, from December 28 to 31, the following officers were elected: *President,* Dr. Erwin F. Smith, Bureau of Plant Industry, Washington, D. C.; *Vice-president,* Dr. Mel. T. Cook, New Jersey Agricultural Experiment Station, New Brunswick, N. J.; *Secretary-Treasurer,* Dr. C. L. Shear, Bureau of Plant Industry, Washington, D. C.; *Councilor,* Dr. F. D. Kern, Pennsylvania State College, State College, Pa. Dr. E. C. Stakman, Minnesota Agricultural College, Minneapolis, Minn., was elected a member of council vice Dr. Mel. T. Cook. Dr. W. A. Orton was elected one of the chief editors of *Phytopathology,* and Professor H. T. Gussow, Dr. C. W. Edgerton, Dr. E. C. Stakman and Dr. V. B. Stewart were elected associate editors.

At the annual meeting of the American Anthropological Association held in Washington, D. C., December 27–31, the following officers were elected for the year 1916: *President,* F. W. Hodge, Bureau of American Ethnology, Washington, D. C.; *Secretary,* George Grant MacCurdy, Yale University, New Haven, Conn.; *Treasurer,* Neil M. Judd, U. S. National Museum, Washington, D. C.; *Editor,* Pliny E. Goddard, American Museum of Natural History, New York, N. Y.

Dean Haskell, of the college of civil engineering of Cornell University, has been appointed a member of a board of consulting engineers which is to advise State Engineer Williams about the work of completing the New York barge canal.

The directors of the port of Boston have requested Professor C. M. Spofford, of the Massachusetts Institute of Technology, to act with Mr. Guy C. Emerson and the engineer of the board, Mr. F. W. Hodgdon, as consulting engineers on the construction of the great new dry dock. Already the port directors had

made arrangements with Professor E. F. Miller, head of the department of mechanical engineering, for the testing of materials to be used in construction.

DR. LYSANDER P. HOLMES, of the health department of New York City, has been appointed third assistant superintendent in the John Hopkins Hospital.

DR. GAIUS E. HARMON, instructor in hygiene and preventive medicine in the medical school of Western Reserve University, has been appointed assistant registrar of the Bureau of Vital Statistics to the Cleveland City Division of Health.

ON December 15, 1915, Dr. C. Stuart Gager addressed the Rhode Island Horticultural Society, at Providence, on the effects of electricity and radium-rays on the growth of plants.

THE Royal Institution, following an example set by many theaters in London, has arranged that for the present the discourses usually given on Friday evening shall be delivered at 5.30 P.M. The first was announced for January 21 by Sir James Dewar, on problems in capillarity; the second, by Dr. Leonard Hill on January 28, on the science of clothing and the prevention of trench feet; and the third, by Professor William Bateson, on February 4, on fifteen years of Mendelism.

A MEMORIAL service for the late Sir Henry Roscoe was held on December 22 at the Rosslyn Hill Unitarian Chapel. We learn from *Nature* that the Royal Society was represented by the president—Sir J. J. Thomson—Professor Arthur Schuster, Sir Edward Thorpe and Professor Smithells; University College (University of London) by the vice-chancellor, Sir Alfred P. Gould, Sir Thomas Barlow, Professor M. J. M. Hill (chairman of the academic council) and Dr. Gregory Foster (the provost); the Victoria University of Manchester by the vice-chancellor, Sir Henry Miers and Professor H. B. Dixon; the Chemical Society by Dr. Smiles and Professor J. C. Philip (secretaries), and Lieut.-Col. A. W. Crossley (foreign secretary); the Society of Chemical Industry by Sir Boverton Redwood and Mr. Watson Smith; the National Physical Laboratory by Dr. Glazebrook and Dr. Harker; the Lister Institute by Dr. Harden; the Royal Commissioners for the Exhibition of 1851 by Mr. Evelyn Shaw.

DR. B. L. MILLIKIN, M.D. (Pennsylvania, '79), former dean of the medical school, Western Reserve University, and senior professor of ophthalmology and senior consulting surgeon on eye diseases at Lakeside Hospital at the time of his death, died suddenly on January 6.

DR. GEORGE THOMAS JACKSON, formerly professor of dermatology at the College of Physicians and Surgeons, Columbia University, has died of pneumonia, at the age of sixty-four years.

DR. H. DEBUS, F.R.S., formerly professor of chemistry at the Royal Naval College, Greenwich, and lecturer on chemistry at Guy's Hospital, has died in his ninety-second year.

MR. W. RUPERT JONES, who was for forty years assistant librarian of the Geological Society of London, has died at the age of sixty years.

IT is reported that the commonwealth of Australia is prepared to expend whatever sum is necessary to establish and administer an institution for the development of scientific and industrial research, even if the cost amounts to half a million pounds.

WORK is now under way for the completion of the laboratory building and first range of plant houses at the Brooklyn Botanic Garden. The completion of these buildings at this time was made possible by the donation, by three friends of the garden, of $100,000 on the condition that a like sum be appropriated for the same purpose by the City of New York.

BY resolution of the board of directors it has been decided to name the new building of the University of Pennsylvania Museum the "Charles Custis Harrison Hall." This part of the museum consists of a dome which is unique in American architecture. The dome is 100 feet in diameter and 120 feet in height. In the lower part is an auditorium seating 1,000. Above this is an exhibition room, 100

feet in height. This Harrison dome cost $300,000, and will house some of the most important exhibits of the museum. It was named in honor of Dr. Harrison because its construction was largely due to his efforts.

The collection of gem-stones formed by the late Sir Arthur H. Church has, in accordance with a wish expressed in his will, been presented by his widow to the trustees of the British Museum, and is now on exhibition in the recent addition case in the Mineral Gallery of the Natural History Museum at South Kensington. It comprises about two hundred selected and choice faceted stones, most of them mounted in gold rings.

Mr. M. P. Skinner, a member of the American Museum, has presented to the institution some valuable motion-picture films and photographs of animals of the Yellowstone Park, obtained during his twenty years' experience in that region.

Loaned temporarily to the Archeological Museum of the Ohio State University for use during the convention of the American Association for the Advancement of Science were three private archeological collections. The owners are Henry F. Buck and F. P. Hills, of Sandusky, and D. C. Matthews, of Cleveland. Many interesting and valuable specimens were included in these collections, and they were of especial importance from a collector's standpoint. "The university museum attracted great interest during the convention," said Curator W. C. Mills. "Collectors from all over the country keenly enjoyed the displays set forth, and displayed interest in the lectures and talks." The Hyde collection, which was donated to the museum some time ago, is now installed and on exhibition.

The annual report of the committee on library of the New York Academy of Medicine, issued on January 1, shows a great decrease in the average of medical books published in Europe during 1915. During 1913 the academy received 704 French and German publications but during 1915 only 435.

At the ninety-seventh convocation recently held at the University of Chicago twenty-five students, nominated by the departments of science for evidence of ability in research work, were elected to the honorary scientific society of Sigma Xi.

On January 7, twenty-nine members of the faculty of the University of Missouri, belonging to the departments of history, sociology, anthropology, philosophy, psychology, education, economics, political science, law, etc., met and organized a new professional fraternity, Alpha Zeta Pi (Anthropos Zoon Politikon), for the promotion of the social sciences. While the present organization is a purely local one, the organizers have had in mind the possibility of similar societies in various institutions of the country getting together and forming a national organization with the same purpose. Alpha Zeta Pi will attempt to do for the social sciences what Sigma Xi is doing for the natural sciences. Students who have distinguished themselves in the university by giving special promise of future achievement in the social sciences, will be stimulated by being elected student members of the fraternity, and may later be elected permanent members. Both student members and permanent members will have equal rights in the fraternity. The fraternity will meet every month for the discussion of scientific problems. At the next meeting, in February, the first election of students (both graduate and undergraduate) to membership in the fraternity will take place. The officers for the present academic year are: *President,* M. F. Meyer; *Vice-president,* C. A. Ellwood; *Secretary-Treasurer,* J. E. Wrench.

Dr. John G. Bowman, of Chicago, director of the American College of Surgeons, states that the college begins the new year with the announcement that it has obtained from its fellows an endowment fund of $500,000, to be held in perpetuity, the income of which only is to be used in advancing the purposes of the college. The college has been in the process of formation for the last three years. It has a temporary office in Chicago and it is probable that permanent headquarters will be decided upon within a few days. The president

is Professor John Miller Turpin Finney, head of the surgical clinic of Johns Hopkins Hospital, Baltimore. It is modelled after the Royal College of Surgeons of England and has the support, it is said, of nearly all the leading surgeons in this country and Canada. "The college, which is not a teaching institution, but rather a society or a college in the original sense," Dr. Bowman says, "now lists about 3,400 fellows in Canada and in the United States."

DR. CHARLES P. STEINMETZ writes in the *Electrical World* that the Illuminating Engineering Society in 1916 celebrates the decennial of its existence. This will be an occasion to review and record what has been accomplished in the art and to initiate plans for future advance, and the society therefore expects a year of greater activity than ever before in all the field covered by it. The illuminating engineer has to deal not only with engineering, like other engineers—that is, with applied physics—but his work includes the problems and the knowledge of physiology and of psychology, is of importance to the ophthalmologist and to the sanitarian, and is closely related to that of the architect, the decorator and the constructor. It is one of the broadest fields of human activity, and it is hoped that the coming year will enable the society to produce a compendium of the entire field of the science and art of illumination and make it available to the practising engineer or architect as well as to the ophthalmologist, the college professor and the student. In celebration of the decennial of the society, a mid-winter convention will be held in February, with numerous technical papers, and the feature of this convention will be the acceptance of honorary membership in the society by the man who has made modern illuminating engineering possible, Thomas A. Edison.

IN addition to the collection of 20,000 vertebrate and 140,000 invertebrate specimens brought from Africa by the Lang-Chapin expedition, the evidence in the shape of photographs by Mr. Lang and colored drawings by Mr. Chapin is unusually varied and complete. Seven thousand photographs help to set forth the animal life of the Congo, as well as the industries, customs, art, ceremonies, amusements and mode of life of the natives; while the ethnological value of the work is supplemented by some seventy casts of heads which Mr. Lang was able to make through the consent of a tribe of Pygmies.

UNIVERSITY AND EDUCATIONAL NEWS

MR. GEORGE T. BAKER has made a further gift of $50,000 to Cornell University.

BARNARD COLLEGE, Columbia University, has received $100,000 from Mr. James Talcott for religious instruction.

A NEW chair at the University of Pennsylvania to be known as the Dr. Isaac Ott chair in physiology, has been endowed through the legacy received from the estate of Dr. Isaac Ott, M.D., '69, of Easton, Pa. The legacy is subject to a life interest of Katherine K. Ott. Dr. Ott, who was a member of the American Physiological Society and a fellow of the American Association for the Advancement of Science, had made important contributions to our knowledge of the physiology and pathology of the nervous system.

ANNOUNCEMENT has been made of a fund established by Samuel Mather, of Cleveland, to found a school for the graduate study of tuberculosis as a memorial to the late Dr. Edward L. Trudeau. The school will probably be located at Saranac Lake, N. Y., and courses will be offered to physicians who wish to become proficient in the diagnosis of tuberculosis. Cooperating agencies for special study will also be established in New York City.

ON the thirteen acres of land lying adjacent to the campus which Western Reserve University has purchased, the erection of a complete new medical institution is contemplated. The present downtown school and hospital sites it is said will eventually be abandoned. Upon the same campus will be housed the dental and possibly the pharmacy schools, which

are at present affiliated with the university and located downtown. A new dental school building is about to be constructed.

The sum of a quarter of a million dollars has been given by Mrs. Russell Sage to the Emma Willard School in Troy to found a department of domestic and industrial art to be known as the Russell Sage School of Practical Art. The new department will occupy the buildings recently vacated by the school on the completion of new buildings made possible by a gift of $1,000,000 from Mrs. Sage in 1907.

We learn from *Nature* that Mr. Patrick Alexander, known by his pioneer work in aeronautics, has made over to the headmaster of the Imperial Service College, Windsor, the sum of £10,000 "for the furtherance of the education of boys of the Imperial Service College, *i. e.*, for the training of character and the development of knowledge." Mr. Alexander had given to the college an aero-laboratory and equipment about five years ago.

Dr. Irving E. Melhus, formerly pathologist, office of cotton and truck diseases of the Bureau of Plant Industry, has assumed charge of the work in plant pathology in the Iowa State College.

DISCUSSION AND CORRESPONDENCE

GENETIC FACTORS AND ENZYME REACTION

In spite of the great progress in the knowledge of facts in genetics the nature of genetic factors may well be regarded as unknown. Various theories have been proposed but only a few steps have been made to attack the problem experimentally. Those who approached it from the physiological-chemical side all seem to agree that the unit-factors are to be compared in some way to enzymes (Loeb, Robertson, Moore, Bateson, Riddle, etc.) or expressed more generally "that the hereditary factor . . . is a determiner for a given mass of certain ferments" (Loeb and Chamberlain, 1915).[1] At first sight there are not many ways visible of an experimental attack on this problem. One is described by Loeb and Chamberlain in the following words:

> If we wish to carry this view (with which we sympathize) beyond the limit of a vague statement, we must either try to establish the nature of these compounds by the methods of the organic chemist, or we must use the methods of general or physical chemistry and try to find numerical relations by which we can identify the quantities of the reacting masses or the ratio in which they combine.

Some steps in this direction have been made by Loeb, Robertson and Ostwald, who tried to prove that the phenomena of growth may be understood as autocatalytic reactions; by Moore, who compared the velocity of development of a dominant character in homozygotes and heterozygotes; by Loeb and Chamberlain, who followed the more indirect way of proving the enzyme-reaction-like basis of a certain kind of fluctuating variability. It is further known that Miss Wheldale and Keeble are approaching the question by a direct study of the chemistry of plant pigments in hybrids of known constitution and quite recently a very interesting paper on hair-pigments in rodents has been published by Onslow.[2]

For some time I have had similar ideas in regard to these questions in connection with genetical experiments, approaching the subject from quite an unexpected side. It was not the intention to publish them before the entire work was finished. But as this will take some years longer and the subject is becoming meanwhile more popular, it might be advisable briefly to point out the ways in which I reached conclusions very similar to those of Loeb, etc.

The genetical reaction which is concerned primarily in my experiments is the pigmentation of the wings of moth. Its dependence upon genetic factors is well known and its chemical character—the amino-acid-oxydase reaction—is comparatively clear. In one set of experiments it could be shown how the quantity of pigment formation depends upon the quantitative combination of the hereditary factors.[3] The experiments were started in 1909 with the purpose of working out the genetics of melanism in moths. The experi-

[1] *Jour. Exp. Zool.*, Vol. 19, 1915.

[2] *Proc. R. Soc. S. B.*, Vol. 89, 1915.

[3] Onslow's results are in the same line.

ments are so far finished, but details about them can not be published, because the records are not available just now. But one point can be stated in a general way. In my example, the nun (*Lymantria monacha*), all gradations are found between a white animal with the characteristic zig-zag bands and a completely black one. The breeding experiments show that these intermediates are to be explained by combinations of some, partly sex-linked, factors for pigmentation. The comparison of the wings shows that the pigmentation starts from certain points of outlet and spreads thence over the wing, gradually encroaching upon the white scales. Obviously there corresponds to every combination of factors, an enzyme reaction, definite in quantity. Of course, the same conclusion could already have been drawn from Nilsson-Ehle's well-known studies on oats. But the meaning of the reaction is so much more evident in the insect case.

The other way which led to similar conclusions in regard to the connection of hereditary factors with the quantity of enzyme reaction is quite an unexpected one. In some previous papers I have published the results of experiments in determination of sex in the gypsy moth and a report upon their further progress is now in press in the *Proc. Nat. Acad. Sc.* The point which concerns us here is the following. We have found a series of races of that moth, which differ in regard to the quantitative behavior of their sex-factors. We could prove that in a cross between these races the resulting sex with all the secondary sex-characters depends upon the quantitative relation of the male and female set of sex factors. In the hybrids all kinds of combinations of these two sets varying in their relative quantity, can be brought together. And the result is that every single step between the two sexes, for which I proposed the term intersexes, may be produced. The external characters of these animals now are determined in the following way: the female factorial set would produce entirely female characters, and in the same way the male set male characters. The real effect is a function of the arithmetical difference of these two. If this difference is in favor of one or both above a certain quantity, say $f - m > x$ or $m - f > z$, the pure sex is produced. But if the difference is beyond the constant minimum z and x, an intersex is produced. And the quantity of intersexuality increases proportionally to the decrease of the values $f - m$ or $m - f$. The effect of such a competition of two sets of factors, both influencing the same characters in different directions, is, of course, the same as if only one factor of a variable quantitative efficiency were present. And now we are able to draw a parallel between the quantities of the hereditary factor and the quantities of the observed enzymatic reaction causing the coloration of the wing.

In the colors and markings of the wings of these moths at least four factors or sets of factors are involved, as is shown by loss-mutations. The normal females have white wings with transverse zig-zag bands, and, in addition, a crescent-shaped spot and a point near it, resembling the Turkish emblem (crescent and star). In the males the same markings are present and also a diffuse color covering the entire wing and varying from light gray to almost black in different races. In a mutation, which appeared some years ago in my cultures, all ziz-zag bands, except the one near the edge of the wing, disappeared. The mutation is not sex-limited and independent of the general color of the wing as is shown by breeding tests. This general color is again subject to mutations in the male; and there appeared another mutation also in which the sex-linkage is broken and the female wings are colored. The following remarks apply only to the normal, general wing-pigmentation, linked with the male sex.

It is known through the work of Federley and others that this pigment flows out from the wing-veins spreading over the entire wing. And it might not be unsafe to say that it is the oxydase which diffuses from the hemolymph in the veins into the scales. If we now study the different grades of intersexuality produced in our experiments, we realize that every step leading from a normal female

through the different grades of intersexes to a male, or, vice versa, from a male to the female, is characterized by a definite intermediate step of wing-pigmentation. The color of the pigment is constant but its quantity is variable. And one sees at first sight that in the different intersexes a certain amount of pigment-producing oxydase, parallel to the quantitative behavior of the sex factors, is furnished by the veins, varying from 0 per cent. in the female to 100 per cent. in the male. If a male is becoming intersexual, white cunei appear between the veins on the brown wing. Their position and shape is irregular. The total unpigmented area in different animals of the same constitution, is, however, approximately the same. With growing intersexuality—as measured by all organs of the animal—the white spots become larger. And an inspection of the wings shows immediately that there must be present an amount of pigment or, more correctly, of oxydase, quantitatively fixed, and corresponding to the quantitative value of $m - f$; and that the given quantity (or concentration) flows out from the veins over the wing, producing brown scales, wherever it happens to come. With increasing inter-sexuality the phenomenon becomes still clearer. A stage is reached, where a white wing shows brown, pigmented venation; in some places a short stream of pigment seems to flow out from a vein. In still more advanced intersexual males, about two thirds transformed into females, only a few pigment spots and stripes are to be found on the wings along the veins. In the female intersexes the opposite process is observed, but the details are somewhat different, showing that these depend upon the genetically given wing structure, different in both sexes.

It seems that this case is an exceedingly clear one, demonstrating the principle ad oculos. But it may be of even greater significance. All organs different in the two sexes are affected in some way by the intersexuality. There is some hope that it might be possible to obtain by their analysis a similar insight in the process of growth, localization, symmetry, etc., involved in morphogenesis. But I think that it is already clear from the foregoing remarks, that we are right, when we reached, independently, the conclusion that the hereditary factor is a determiner for a given mass of ferments; and we can demonstrate it by the fact that a quantitative difference in the potency of hereditary factors causes a parallel, quantitatively different, enzyme production.

Richard Goldschmidt
Osborne Zoological Laboratory,
Yale University,
December, 1915

Early Meetings of the American Association for the Advancement of Science

To the Editor of Science: I am greatly interested in statistics published in your issue of December 3, in regard to the oldest members of the American Association for the Advancement of Science.

While my own membership dates only from 1870, my knowledge of and interest in the association far antedates that year. It seems almost certain that I have known the association by attending its meetings longer than any other person now living.

In 1851, Professor James H. Coffin, of Lafayette College, was a guest at our home in Albany and took me to the meeting in the old capitol.

Again in 1856 he was our guest. I was then a pupil at the Albany Academy, a building of historic interest as the place where Joseph Henry installed the first telegraph. One of the sessions of the association was held in the academy park, at which the Dudley Observatory was dedicated. I well remember the delight with which we watched Professor Agassiz draw figures with both hands while he talked; also the eloquent address of Edward Everett.

Wm. H. Hale
40 First Place, Brooklyn, N. Y.

Scientific Books

The Alligator and Its Allies. By Albert M. Reese, Ph.D., Professor of Zoology in West Virginia University. New York, G. P. Putnam's Sons, 1915. Pp. xi + 342. 62 figures and 28 plates.

The purpose of this volume, as stated in the preface, is "to bring together, in convenient form for the use of students of zoology, some of the more important details of the biology, anatomy and development of the Crocodilia." There are chapters on the biology of the Crocodilia, the skeleton, the muscles, the nervous system, the vascular system, the urogenital system, the respiratory system, the vascular system, and the development of the alligator, and a bibliography containing eighty-nine titles. The book is illustrated by sixty-two figures, about half of them original, and twenty-eight plates. all but six of which are original.

In the chapter on the biology of the Crocodilia, the classification and geographical distribution are briefly summarized, evidently from general works, brief notes on the characteristics of several forms are given, and twenty-nine pages are devoted to a discussion of the habits and economic importance of *Alligator mississippiensis,* principally as revealed in the writer's field work. The description of the muscular system is a translation of Bronn's account of the muscles of *Crocodilus,* with illustrations of the musculature of *Crocodilus* and *Alligator,* and the description of the nervous system is taken from Bronn and others. The description of the digestive, urogenital, respiratory, vascular and skeletal systems are original, as is the account of the embryological development of *Alligator mississippiensis,* the last being a reprint, with some alterations, of an earlier paper by the author published by the Smithsonian Institution.

The author has succeeded in his expressed purpose of making the book detailed, and it will at once find a place in the library of the comparative anatomist and herpetologist as a valuable reference work. In the opinion of the reviewer, the only serious adverse criticism which will probably be made by students is that the chapter upon the embryological development of the alligator is too detailed. A connected and more readable account of the embryology would be of more general value than will be the monotonous descriptions of sections which make up this chapter. It is stated in the publisher's advertisement on the jacket that the book "has an assured appeal for the layman interested in natural history," but this is doubtful, for, in addition to the detailed treatment, the terminology is technical and about seven eighths of the text consists of descriptions of the anatomy and embryology.

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PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

(NUMBER 12)

THE twelfth number of volume 1 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *Salts, Soil-Colloids and Soils:* L. T. SHARP, College of Agriculture, University of California.

   New light is thrown upon the subject of salts in relation with soil-colloids. The way is opened for extensive experiments in the physical chemistry of soils, and the principles involved will be of particular significance for the subject of the applications of alkali and of fertilizer salts.

2. *The Child and the Tribe:* ALICE C. FLETCHER, Peabody Museum, Harvard University.

   The rites connected with the initiation of the child into the tribal life are described with emphasis upon their significance in Indian education and philosophy.

3. *The Correlation of Potassium and Magnesium, Sodium and Iron, in Igneous Rocks:* HENRY S. WASHINGTON, Geophysical Laboratory, Carnegie Institution of Washington.

   The author's earlier suggestion that soda not uncommonly tends to vary with the iron oxides while potash shows similar relations to magnesia is greatly strengthened by a compilation of analyses of igneous rocks, numbering nearly 10,000.

4. *Theorem Concerning the Singular Points of Ordinary Linear Differential Equations:* GEORGE D. BIRKHOFF, Department of Mathematics, Harvard University.

It is shown that transformations of the independent variable have no significance over and above linear transformations of the dependent variables for the purposes of classification with respect to the notion of equivalence.

5. *A Quantitative Study of Cutaneous Analgesia Produced by Various Opium Alkaloids:* David I. Macht, N. B. Herman and Charles S. Levy, Pharmacological Laboratory, Johns Hopkins University.

By the use of exact experimental methods the order of analgesic power in the individual alkaloids from strongest to weakest is found to be: Morphin (10 mg.), papaverin (40 mg.), codein (20 mg.), narcotin (30 mg.), narcein (10 mg.), thebain (10 mg.). The combinations of alkaloids are also studied.

6. *The Surface-Tension at the Interface between Two Liquids:* William D. Harkins and E. C. Humphrey, Kent Chemical Laboratory, University of Chicago.

The substitution of experiments on the liquid-liquid interface for the ordinary method in which a liquid-air interface is used, makes it possible to compare the drop-weight results with those obtained in a capillary tube of large bore. Various advantages appear from the use of this method.

7. *Outlines of a Proposed System of Classification of the Nebulæ by Means of Their Spectra:* W. H. Wright, Lick Observatory, University of California.

The spectra are arranged according to the degree of concentration of 4686A and some of the neighboring lines. The successive nebulæ stand in very close relation to one another, yet at one end of the scale is a purely gaseous nebula, and at the other end a banded star.

8. *Some Probable Identities in Wave-Length in Nebular and Stellar Spectra:* W. H. Wright, Lick Observatory, University of California.

The evidence renders probable the presence in the nebulæ of carbon and nitrogen and fortifies the assumption of a close relationship between the nebulæ and the early type stars.

9. *Energy Transformations During Horizontal Walking:* Francis G. Benedict and Hans Murschhauser, Nutrition Laboratory, Carnegie Institution of Washington.

The metabolism found for the subject walking at moderate speed without food has an average value of ½ gram-calorie. Slow, medium, and fast walking and running are investigated for comparison.

10. *The Physiology of the New-Born Infant:* Francis G. Benedict and Fritz B. Talbot, Nutrition Laboratory, Carnegie Institution of Washington.

The results of experiments on 105 new-born infants give opportunity for suggestions as to supplemental feeding and methods of conserving energy.

11. *A Comparison of Methods for Determining the Respiratory Exchange of Man:* Thorne M. Carpenter, Nutrition Laboratory, Carnegie Institution of Washington.

The apparatus compared were the following: bed respiration calorimeter; two forms of the Benedict universal respiration apparatus; Zuntz-Geppert apparatus; Tissot apparatus; and so on.

12. *Neuro-Muscular Effects of Moderate Doses of Alcohol:* Raymond Dodge and Francis G. Benedict, Nutrition Laboratory, Carnegie Institution of Washington.

Contrary to the theory of Kraepelin, the authors find no facilitation of the motor processes, but the depression of their simplest forms in the finger and eye movements seem to be one of the most characteristic effects of alcohol.

13. *Variation and Inheritance in Abnormalities Occurring after Conjugation in Paramecium Caudatum:* Ruth J. Stocking, Zoological Laboratory, Johns Hopkins University.

In respect to the abnormalities, while some lines are constant in hereditary character, in others hereditable variations do occur within the line, so that, by selection, it is possible to break the single stock into a number of stocks differing hereditarily.

14. *The Influence of the Marginal Sense Organs on Functional Activity in Cassiopea Xamachana:* Lewis R. Cary, Department of

Biology, Princeton University.

There is no direct relationship between the extent of muscular activity and the rate of regeneration. In the absence of the influence of the sense-organs regeneration can take place normally but always at a decidedly lower rate.

15. *Heritable Variations and the Results of Selection in the Fission Rate of Stylonychia Pustulata:* AUSTIN RALPH MIDDLETON, Zoological Laboratory, Johns Hopkins University.

It is possible to give precise data as to the occurrence of heritable variations and their accumulation through selection: and this can hardly fail to have influence on the conception of the genotype as a fixed thing.

16. *Hereditary Anchylosis of the Proximal Phalangeal Joints (Symphallangism):* HARVEY CUSHING, Harvard Medical School and Peter Bent Brigham Hospital, Boston.

The character behaves as a simple Mendelian dominant with equal chance among the offspring of affected individuals that it will be or will not be inherited.

17. *The Relative Stimulating Efficiency of Spectral Colors for the Lower Organisms:* S. O. MAST, Zoological Laboratory, Johns Hopkins University.

The stimulation in all of the organisms studied depends upon the wave-length of the light, and the stimulating efficiency is very much higher in certain regions of the spectrum than in others, but the regions differ in certain organisms closely related in structure.

18. *The Mission Range, Montana:* W. M. DAVIS, Department of Geology, Harvard University.

This range seems unique in its systematic tripartite arrangement of normally and glacially sculptured forms.

19. *Definition of Limit in General Integral Analysis:* ELIAKIM HASTINGS MOORE, Department of Mathematics, University of Chicago.

The definition is noteworthy in that it involves no metric features of the range $\mathfrak{P}$ underlying the range of definition of the function $F(\sigma)$.

This number of the *Proceedings* contains also a notice of the memoir by Charles C. Adams on "The Variations and Ecological Distribution of the Snails of the Genus *Io*"; the Report of the Autumn Meeting, and the Index and Table of Contents of the complete volume, including a list of the officers and members of the academy.

We may summarize the articles in Volume 1 of the *Proceedings* as follows: Mathematics, 21; Astronomy, 31; Physics, 7; Chemistry, 21; Geology and Paleontology, including Mineralogy and Petrology, 10; Botany, 4 (see also Genetics); Zoology, 15 (see also Genetics); Genetics, 17; Physiology and Pathology, including Bacteriology, 24; Anthropology, 12; Psychology, 3; a total of 165 articles.

The division of these articles between members of the academy and non-members is 55 and 110, respectively.

The list of institutions which have contributed three or more articles is as follows: Carnegie Institution 34, divided as follows: Solar Observatory 17, Nutrition Laboratory 9, Station for Experimental Evolution 5, Marine Biology 2, Geophysical Laboratory 1; University of Chicago 20; University of California 17; Harvard University 16; Johns Hopkins University 11; Rockefeller Institute 11; University of Illinois 8; Yale University 6; Princeton University 5; Smithsonian Institution 4; U. S. National Museum 4; Stanford University 4; American Museum of Natural History 4; U. S. Geological Survey 3.

EDWIN BIDWELL WILSON

RECENT PROGRESS IN VERTEBRATE PALEONTOLOGY

THREE years ago the Paleontological Society of America published a symposium, the purpose of which was to present a review of the progress made during the preceding decade in paleontology. Since 1911 there have been published in the American Year Book brief summaries of the more important results of investigation in this field throughout successive years. The extreme brevity of these reviews has rendered them less useful to students than

might have been the case had they been accompanied by critical notes, or had they been prepared with the same fulness as Dr. Lydekker's valuable discussions in Science Progress for the last few years. It is hoped that the following account of the year's achievements in the field of vertebrate paleontology may, in a measure, supply the deficiency which has heretofore existed.

Fishes.—Owing to the stress of conditions abroad, it is natural that the chief advance in vertebrate paleontology since the war began should have been made in this country. Nevertheless, several very important contributions by foreign authors are to be recorded. Among the latter may be mentioned Dr. A. S. Woodward's generalizations on the evolutionary history of the class of fishes, as contained in his anniversary address before the Geological Society of London (February 19, 1915). The net result of this author's observations is thus formulated:

> Each successive great group of fishes began with free-swimming fusiform animals. . . . Some of them always passed quickly into slow-moving (deep-bodied or grovelling, depressed and large-headed) types, while others changed more slowly into elongated or eel-shaped types. There was also a constant tendency for the primitive symmetry of the parts of the skeleton in successive members of a group to become marred by various more or less irregular fusions, suppressions and subdivisions. Finally, some of the successive species of each group gradually increased in bodily size until the maximum was reached, just before the time for extinction had arrived. These and many other more special changes have now been traced in a general way in each group, and the various geological periods at which they occurred have been determined by observations on fossil fishes from many parts of the world.

Professor F. Priem, of Paris, presents a valuable account of the Cretaceous and Eocene fishes of Egypt,[1] and has continued his studies on Upper Tertiary fish remains from southwestern France.[2] Dr. Edward Hennig, of the Berlin Museum, reports the interesting discovery of otoliths in the type species of *Palæoniscus,* from the Permian of Saxony. A note on the parasphenoid bone of the same genus, by Henry Day,[3] contains observations which lead the author to conclude "in favor of a primitive Teleostome, and against a Dipnoan, derivation of the Tetrapoda." African fossil fishes form the subject of two contributions by Edward Hennig,[4] and a further one by Ernst Stromer von Reichenbach,[5] of Munich.

In this country Dr. R. L. Moodie,[6] of the University of Illinois, has reinvestigated the fossilized brain-structure and auditory organs of a small Palæoniscid species, *Rhadinichthys deani,* first described by Eastman and Parker from specimens found in the Waverly of Kentucky. Similar remains are also reported from the Caney shale of Oklahoma, and the Pennsylvanian of Lawrence, Kansas. The same author also reviews the literature relating to fossil brain casts of dinosaurs and other extinct animals. Some additions to our knowledge of the Jurassic fish-fauna of Solenhofen and Cerin, France, are made by C. R. Eastman in his studies of Carnegie Museum material.[7]

Dr. W. K. Gregory,[8] of the American Museum of Natural History, presents a concise review of the evolutionary history of the principal groups of fishes, with special reference to the skull and locomotor organs. He brings together considerable evidence for the view that certain of the Devonian Crossopterygii were related to the four-footed terrestrial vertebrates, and attempts to trace the gradations by which the pectoral and pelvic fins of these fishes were transformed into the fore and hind limbs of the earliest amphibians.

[1] *Bull. Soc. Geol. France,* Vol. 14, pp. 366–382, pl. X.

[2] *Ibid.,* pp. 119–131; 249–278.

[3] *Ann. Mag. Nat. Hist.,* Vol. 16, pp. 421–434.

[4] *Archiv. f. Biontologie,* Vol. 3, pp. 291–312. This is on fish remains obtained by the Tendaguru expedition. The second paper, on *Semionotus* from South Africa, is published in the *Sitzber. Ges. Naturf. Freunde Berlin,* 1915, pp. 49–51.

[5] *Zeitschr. Deutsch. Geol. Ges.,* Vol. 66, pp. 420–425.

[6] *Jour. Compar. Neurology,* Vol. 25, No. 2.

[7] *Mem. Car. Mus.,* Vol. 6, Nos. 6, 7.

[8] *Annals N. Y. Acad. Sci.,* Vol. 26, pp. 317–383, pl. IV.

Amphibians.—Professor S. W. Williston,[9] of the University of Chicago, in his discussion of the genus *Trimerorachis,* from the Permian of Texas and Oklahoma, argues that this interesting animal, which is in some respects more fish-like than any other known amphibian, represents a secondary adaptation to aquatic habits, and that its ancestors were more terrestrial, and therefore less pisciform in structure and habits. Dr. Carl Wiman,[10] of Upsala, has published an important memoir on the abundant Stegocephalians of the Trias of Spitzbergen, which, as remarked by Broili, were probably marine animals.

Dr. F. Broili,[11] of Munich, contributes an interesting discussion of *Tanystrophæus conspicuus* von Meyer from the Muschelkalk of Bayreuth, an animal known from certain excessively elongate caudal vertebræ. The author adopts as most probable Cope's sagacious determination of these strange vertebræ as representing a small Theropodous dinosaur, an opinion also adopted by Baron von Huene.

Dr. R. L. Moodie[12] describes a remarkable amphibian from the Pennsylvanian of Ohio which combines early amphibian and reptilian characters in the limbs. The same author, in describing the scales of certain Carboniferous amphibians[13] comments on their resemblances to and differences from the scales of fishes. In the *Kansas University Science Bulletin* Dr. Moodie gives a list of the described species of fossil amphibians, comprising more than 300 entries. Again, in the September number of the *American Naturalist,* the same author contrasts the amphibians of the Coal Measures with their supposed relatives among fringe-finned ganoids, and shows that even at that remote period the Amphibia and Crossopterygii were structurally far removed from each other; so that their common ancestors, if any such existed, must be sought in some much earlier period.

[9] *Jour. Geol.,* Vol. 23, pp. 246–255.

[10] *Bull. Geol. Inst. Upsala,* Vol. 13, 9 plates and 10 figs.

[11] *Neues Jahrb. Mineral.,* Jahrg. 1915, Vol. 2.

[12] *Amer. Jour. Sci.,* Vol. 29.

[13] SCIENCE, March 26, 1915.

Professor E. C. Case, of the University of Michigan, contributes an important memoir on the Permo-Carboniferous Red Beds of North America and their Vertebrate Fauna.[14] He describes the geological structure and relations of these beds, the character of the environment, and discusses the life habits and appearance of many of the fossil amphibians and reptiles found there, giving restorations of a score of these strange creatures.

Reptiles.—Dr. R. Broom, of London, has prepared an illustrated catalogue of the Permian Triassic and Jurassic reptiles of South Africa.[15] This collection was made by Dr. Broom in South Africa and purchased from him by the American Museum of Natural History; it includes a large series of skulls and partial skeletons, representing many genera and families of the mammal-like reptiles (Therapsida). The same author in his Croonian lecture on the Origin of Mammals[16] discusses the anatomical evidence for the derivation of the mammals from one or another of the Therapsid group, especially the earlier Cynodontia, which are the most mammal-like of all the South African reptiles.

D. M. S. Watson, of University College, London, in the *Proceedings of the Zoological Society of London,* December, 1914, describes and analyzes the skull structure of *Bauria, Microgomphodon, Arctops* and other important South African Permian types. These researches are all in harmony with the now widely held view that the mammals have arisen from some of these mammal-like reptiles, but the connecting links have not yet been discovered. In another paper[17] Watson describes the anatomy of the Deinocephalia, one of the most curious of the South African groups. Some of these animals were of huge size, with massive limbs and an arched back, like a gigantic *Echidna,* but with a swollen, short-beaked skull.

[14] Carnegie Inst. Washington, Pub. No. 207.

[15] *Bull. Amer. Mus. Nat. Hist.,* Vol. 25, Part 2.

[16] *Phil. Trans. Roy. Soc. London,* 1914, Vol. 206 *B.*

[17] *Proc. Zool. Soc. London,* September, 1914.

Mr. Watson has also described[18] a peculiar Permian South African reptile named by Seeley *Eunotosaurus africanus,* which appears to give the long-sought clue to the origin of the Chelonia. The turtles and tortoises, it will be remembered, are the only vertebrates in which the pelvis and shoulder-girdle have been drawn inward under the expanded and projecting ribs. In *Eunotosaurus,* the ribs are expanded and of the same number as in the Chelonia, while the back was armored with dermal scutes of similar number and position; but the shoulder-girdle and pelvis still retain their primitive positions and the skull also retained teeth, which are lost in the Chelonia.

In this connection must be recorded a work by Professor Hugo Fuchs, of Strassburg, on the structure and development of the skull of *Chelone imbricata,* the first part of which, on the cartilage skull and visceral arches, is a quarto of 325 pages, 6 plates and 182 text figures (Stuttgart, 1915). Here are discussed many far-reaching morphological questions such as the derivation of the lateral wings of the sphenoid bone and the origin of the mammalian auditory ossicles.

The latter subject, after nearly a century of discussion, has of late years received special illumination from the investigations of Professor Gaupp, of Freiburg, who has ably supported Reichert's view that the mammalian incus has been derived from the reptilian quadrate, the malleus from the articular. Reichert's theory has encountered certain objections based upon supposed differences in the position of the auditory ossicles with reference to the hyoidean gill slit and to the chorda tympani nerve in reptiles, birds and mammals. Mr. E. S. Goodrich, of Merton College, Oxford, has definitely cleared up this intricate matter in a superb series of figures showing the developmental relations of the chorda tympani in the different classes of vertebrates. His results lend very strong support to Reichert's theory.[19]

In a memoir entitled "Triassic Life of the Connecticut Valley"[20] Professor R. S. Lull, of Yale University, gives a highly readable biological and geological account of the Connecticut Valley during the Triassic Period and of its teeming inhabitants, especially the dinosaurs. The later dinosaurs have been the subject of important contributions by several American authors whose papers may be noted as follows:

Mr. C. W. Gilmore,[21] of the U. S. National Museum, has given a very thorough and well illustrated description of the osteology of *Stegosaurus* based upon the skeleton and other specimens in the U. S. National Museum. Briefer notices by the same author[22] are upon the restoration of *Stegosaurus* and upon the fore-limb of *Allosaurus,* the latter settling a problem that had been a standing annoyance and cause of confusion in dinosaur paleontology of the last thirty years.

Dr. W. J. Holland[23] has published some preliminary results of his researches upon the magnificent series of Sauropodous dinosaurs secured in Utah by Mr. Earl Douglass for the Carnegie Museum. He finds that the skull referred by Marsh to *Brontosaurus* is probably wrongly collated, the true skull of this genus being much nearer the *Diplodocus* type. The tail of *Brontosaurus* he finds, like that of *Diplodocus,* ends in a long slender whip-lash and is at least ten feet longer than the published reconstructions have indicated.

Mr. Barnum Brown and Lawrence M. Lambe have published a number of highly important articles descriptive of the magnificent series of dinosaur skulls and skeletons obtained from the Cretaceous of Alberta by Mr. Brown for the American Museum of Natural History and by Mr. Sternberg for the Victoria Museum in Ottawa, Canada.

Dr. Edward Hennig,[24] of the Berlin Mu-

[18] *Proc. Zool. Soc. London,* December, 1914.

[19] *Quarterly Journal of Microscopical Science,* 1915.

[20] Bulletin No. 24, State Geol. and Nat. Hist. Survey Connecticut.

[21] *Bull. U. S. Nat. Mus.,* No. 89, December 31, 1914, p. 147.

[22] *Proc. U. S. Nat. Mus.,* 1915, Vol. 49, pp. 355–356, pl. 52; *ibid.,* pp. 501–513.

[23] *Annals Carnegie Mus.,* Vol. IX., pp. 273–278.

[24] *Sitzber. Ges. Naturf. Fr. Berlin,* 1915, pp. 203–247.

seum, has described and figured various skeletal bones of the new armored dinosaur whose remains are found in great numbers in the Tendaguru dinosaur quarries of German East Africa. He points out its marked differences from *Stegosaurus,* compares it more slightly with the European genera *Omosaurus, Polacanthus,* etc., and describes it as new under the (unfortunately preoccupied) name of *Kentrosaurus.*

A handbook on Dinosaurs by Dr. W. D. Matthew published by the American Museum of Natural History describes and illustrates the principal exhibits in this museum and discusses their characteristics, and the place in nature occupied by this extinct order of reptiles.

Mammals.—Progress in this branch of vertebrate paleontology during the past year has been mainly in continuance of researches, presenting few salient points of interest. The most important contributions of the year on fossil mammals deal with the order Primates, and there should be mentioned first of all those relating to primitive man. In our own language three books have appeared during the year which treat of prehistoric human remains; of these the foremost place must be accorded to Professor Henry Fairfield Osborn's "Men of the Old Stone Age," which presents in accurate and very interesting style the latest results of scientific research upon the environment, habits and art on paleolithic man. "The Antiquity of Man," by Mr. Arthur Keith, sets forth with admirable lucidity and literary style the somewhat extreme views of its distinguished author upon the great antiquity of the modern types of man and his early divergence from the remaining primate stems. The third volume, "Prehistoric Man and His Story," by Dr. Scott Elliott, includes excellent photographs of the remarkable series of statuettes representing primitive and ancestral types of man executed under direction of Professor Rutot. It can not be said to rank with the two first-mentioned books in authority, the Tertiary paleontology and American archeology being especially weak.

A most important contribution has been added by Gerritt S. Miller[25] to the controversy that has raged around the famous Piltdown skull. Dr. Miller analyzes with care the evidence for and against the association of the skull fragments with the lower jaw and compares the latter with a large series of chimpanzee jaws in the National Museum. He comes to the conclusion that the jaw is in every respect within the limits of individual variation of the chimpanzees, and displays no distinctively human characters, while the skull fragments display in every particular the characters of the genus *Homo.* Not only is there an entire lack of blending of these two distinct types of skull, but in such parts as should show coordinated characters and adjustment of one to the other, such conformity is wholly lacking.

In the present reviewer's opinion [W. D. M.] Dr. Miller's argument is convincing and irrefutable; the jaw belonged to a chimpanzee and the skull to a species of man comparable with that represented by the Heidelberg jaw. It is hardly to be expected, however, that this conclusion will be readily accepted by the European writers, who have with but few exceptions committed themselves more or less deeply to the opposite view.

It is quite true, as Professor Boule has observed, that nature affords many instances of unexpected combinations of different types, and no one need be surprised to see an ape-like dentition combined with a man-like brain-case. Indeed, Elliott Smith has adduced excellent reasons why we may well expect to find such a combination. But it is necessary here to distinguish between the concepts of resemblance and identity. The Piltdown jaw is *not* simply a jaw similar in adaptive specialization to that of an ape, it is a jaw identical with that of the chimpanzee in every particular. The skull is not merely similar in brain-case to that of man, it is the skull of *Homo* in every particular. For such a combination as this, with its

[25] *Smithson. Misc. Coll.,* Vol. 65, No. 12.

utter lack of blending, correlation or coordination of interrelated parts, one set of fragments identical with one, the other set identical with another animal of diverse type, not merely similar each to each—such a combination is without parallel and is not reasonably possible. To cite a familiar instance, the teeth of the chalicotheres have a general adaptive resemblance to the titanotheres, the skull and neck to the horses, the claws to the edentates. This is a combination quite unexpected, but nevertheless a quite possible one, and of course well proven. But if one should find a jaw identical in every particular with that of a titanothere associated with a cranium identical in every way with that of *Equus* and claw-phalanges agreeing in all respects with *Mylodon,* it would not be reasonably possible that they could belong to a single animal, no matter what arguments of association and distribution were adduced to support such a conclusion.

Turning to mammals exclusive of man, we may note first a paper by Dr. Guy E. Pilgrim,[26] of the Geological Survey of India, in which are described a number of new or little-known anthropoids from the Miocene and Pliocene of India. The author discusses the affinities of the higher primates and the ancestry of man in the light of the new evidence and regards the extinct genus *Sivapithecus* as very near to the direct ancestry of man. *Pithecanthropus* he considers to be approximately intermediate, while the Piltdown man (*Eoanthropus*) and Neanderthal man (*Homo neanderthalensis*) are relegated to a side branch derived from an earlier stage in the ancestral series than *Sivapithecus*. Pilgrim's conclusions in regard to other extinct and existing genera are no less unexpected. Among the living anthropoids the gibbon is considered nearest to the hominid stem. One species of the Miocene *Dryopithecus* is believed to be related to the gorilla, and the new genus *Palæosimia* to the orang. Pilgrim's views are criticized by W. K. Gregory.[27]

The well-known anthropologist Professor Gustav Schwalbe[28] of Strassburg contributes an extended description of *Oreopithecus* and a conservative discussion of the affinities of this ape of the European Miocene.

Dr. W. K. Gregory[29] summarizes his studies on the lemuroid Primates and discusses the evolution and relationships of the lemuroids of the Eocene of North America and Europe. A significant feature in this author's classification is the association of all the living and extinct lemurs of Madagascar, in spite of their diversity of form and size, in a single group, more primitive than the African and Oriental lemuroids, and nearly related to the Eocene *Adapis* and *Notharctus* of Europe and North America. The African bush-baby (*Galago*) and East Indian loris (*Nycticebus*) are more progressive types, the tarsier (*Tarsius*), although still grouped with the Lemuroidea, in many respects approaches the higher primates. The group of small Eocene primates known as Anaptomorphidæ are now included under the Tarsiidæ; *Necrolemur* of the French Oligocene is related to *Tarsius* and *Galago,* but, with *Microchœrus,* is held in a distinct family.

The conclusions just enumerated, based upon anatomical grounds, have a most important bearing upon the evolutionary history and dispersal of the primates. That Madagascar has served as a refuge for primitive survivals of a group once widespread is not surprising. That the diversity of the Malagasy primates covers an underlying near affinity points to their derivation from a single stock, not from the remnants of a diverse lemuroid fauna of the adjoining continents.

Dr. W. D. Matthew and Mr. Walter Granger[30] describe a series of new or little known primates and primate-like Insectivora from the North American Eocene and trace the history of these groups through the successive horizons of the Eocene. In the best known group of these Eocene lemuroids, the

[26] *Records Geol. Surv. India,* Vol. 45, pp. 1–74; 4 pls. and 2 figs.

[27] Science, Vol. 43, pp. 341–342.

[28] *Zeitsch. f. Morph. Anthr.,* Vol. 19, pp. 149–254.

[29] *Bull. Geol. Soc. Amer.,* December, 1915.

[30] *Bull. Amer. Mus. Nat. Hist.,* Vol. 33, Part I., Carnivora, W. D. M.; Parts II. and III., Condylarthra, W. D. M. and W. G.; Part IV., Primates, etc., W. D. M.

Notharctidæ, the evolution of the teeth is traced through a series of minute gradations from the base of the true Eocene to its upper levels. A restudy of the famous "*Anaptomorphus*" skull, with newly discovered referred material shows that it is a distinct genus from the lower jaw upon which this genus was originally founded; the dentition of several other genera of this group is described chiefly on new material, and all are referred to the same family as the modern tarsier. Two other groups, imperfectly known and of doubtful affinities, the Microsyopidæ and Apatemyidæ, are retained in the Insectivora, but their primate resemblances pointed out.

The above-mentioned papers add largely to the data for reconstructing the evolutionary history of the order primates, including man, a line of investigation that is being actively followed. The latest results of researches upon the "Piltdown Man" (*Eoanthropus*) are summarized in the British Museum Guide to the Fossil Remains of Man.

An interesting announcement by Matthew and Granger in the paper above cited is of the discovery of a relative (*Arctostylops*) of the peculiar Notoungulates of South America in the North American Eocene. These extinct hoofed animals were abundant in the Tertiary of South America, but were supposed to be wholly limited to that continent. Although this announcement rests solely upon the evidence of a lower jaw, the pattern of the premolar and molar teeth is so characteristically like the Notoungulate type and so unlike any other that it is regarded as reasonably certain.

Other sections of the same revision cover the Condylarthra (*Phenacodus, Ectocion, Meniscotherium, Hyopsodus,* etc.) and the primitive Carnivora or Creodonta. The true distinctive characters of the genera and species of these groups, based upon far larger collections than had been previously known, are described, several new genera and many new species described, and the exact geologic horizon and range of each species is specified. The affinities of each species to those of earlier and later horizons are discussed, and the materials and evidence brought together for a faunal and phylogenetic final chapter when the revision has been completed.

The skeleton of *Myotragus,* a remarkable type of antelope discovered in the Pleistocene caves of the Balearic Islands by Miss Dorothea Bate is described by Dr. C. W. Andrews[31] of the British Museum of Natural History. It is allied to the rupicarpine antelopes, but distinguished by a single pair of much-enlarged rodent-like incisor teeth. From the later Tertiaries of California Professor J. C. Merriam,[32] of the University of California, describes various new three-toed horses and other mammals, and Dr. O. P. Hay,[33] of the U. S. National Museum, describes a skull of the rare and peculiar Sirenian *Desmostylus.* Dr. Hay has also published several valuable contributions on American Pleistocene mammals, especially of Iowa.[34] From the Pliocene of Nebraska, Professor E. H. Barbour,[35] of the University of Nebraska, has secured a number of new proboscidean skeletons and skulls, adding largely to our knowledge of this interesting group. Mr. H. J. Cook,[36] of Agate, Nebraska, and Dr. W. J. Sinclair,[37] of Princeton University, also describe a number of new Pliocene mammals from Nebraska, including a remarkable antelope with scimitar-shaped horns. From the basal Eocene of Montana Mr. J. W. Gidley,[38] of the U. S. National Museum, describes a lower jaw referred to the Myrmecobiidæ or banded anteaters of Australia.

[31] *Phil. Trans. Roy. Soc. London,* Vol. 206, *B,* pp. 281–305, 4 pls.

[32] "New Protohippine Horses" and other titles in *Bulletins* of Dept. Geology, Univ. California; *Popular Science Monthly,* March, 1915, pp. 245–264.

[33] *Proc. U. S. Nat. Mus.,* Vol. 49, pp. 381–397, 3 pls.

[34] Ann. Report Iowa Geol. Surv., Vol. 23, pp. 1–506, 75 pls. *Proc. U. S. Nat. Mus.,* Vol. 48, pp. 515–575, 7 pls.

[35] *State Journal,* Lincoln, Neb., January 3, 1915.

[36] Four articles in *Rep. Nebraska Geol. Survey,* Volumes 4 and 7.

[37] *Proc. Amer. Phil. Soc.,* Vol. 54, pp. 73–95.

[38] *Proc. U. S. Nat. Mus.,* Vol. 48, pp. 395–402, pl. XXIII.

[In the reviewer's opinion this jaw agrees in most of its characteristic features with the Leptictidæ, a family of Insectivora, and the single feature of resemblance to *Myrmecobius*, the relative height of inner and outer trigonid cusps is by no means sufficient evidence for relationship to the marsupials. The tooth considered by Mr. Gidley to be the first molar appears to the reviewer to be clearly a fourth premolar, as it is set deeper in the jaw and less worn than the tooth behind it, belongs therefore to the successional series or premolars, not to the first series of cheek teeth (milk and true molars), and is characteristically like the fourth premolar of all the Leptictid genera, especially that of an undescribed genus from the Paleocene (Torrejon formation). The skull and skeleton characters of *Myrmecobius* are, on the other hand, in near agreement throughout with the polyprotodont marsupials, and wholly at variance with Gidley's conclusion of an independent parallel evolution of the group from pre-Tertiary ancestors. W. D. M.]

An important monograph by Professor H. Winge,[39] of Copenhagen, upon the Edentata of the Pleistocene of Brazil includes an authoritative systematic revision of the order, and critical notes of great interest.

Dr. O. Abel, of Vienna, has published a small but richly illustrated book entitled "Die vorzeitlichen Säugetiere." American fossil mammals are exceptionally well represented.

Under the title of "Climate and Evolution" Dr. W. D. Matthew,[40] of the American Museum of Natural History, presents a theory accounting for the observed geographical distribution of animals in present and past ages. He begins by applying to the facts certain modern geological doctrines, such as the correlated alternations of elevation and of climate during geological time, the isostatic balance of continental and ocean masses, and the persistence of the great continental masses which never sank to abyssal depths, but often permitted the sea to make temporary incursions upon their surfaces. Partly by means of a remarkable series of maps, showing the present and past distribution of many races of mammals, the author adduces very weighty evidence for the view that these races originated in the northern continents and then spread southward into South America, Africa, southeastern Asia and Australia.

Professor H. F. Osborn,[41] of the American Museum of Natural History, contributes to the American Naturalist an extended study of certain features of the process of evolution. Basing his conclusions on a wide range of zoological, experimental and paleontological data, he develops the distinction between "rectigradations," or qualitatively and numerically new characters and "allometrons," or changes in proportion, degree or intensity.

The same author[42] summarizes the successive advances and retreats of the continental glaciers and the corresponding shiftings of the floras, faunas and human populations. The special feature of this paper is the demonstration that in Europe, as in America, the so-called "warm fauna" survives until the advance of the fourth glaciation. The last topic is more fully treated in Professor Osborn's recently published work entitled "Men of the Old Stone Age." Here the author gives a detailed description and analysis of the long series of Paleolithic stages in Europe, with a series of new restorations of *Pithecanthropus*, of *Eoanthropus* and of the Races of Neanderthal and Crô-Magnon.

C. R. Eastman,
W. K. Gregory,
W. D. Matthew

[39] "Aftryk af 'E Museo Lundii' Köbenhaven," 1915.

[40] *Annals N. Y. Acad. Sci.*, Vol. 24, 1915.

[41] *American Naturalist*, Vol. 49, April, 1915, pp. 193–239.

[42] "Revision of the Pleistocene of Europe, Asia and Northern Africa," *Annals N. Y. Acad. Sci.*, July, 1915.

SPECIAL ARTICLES

A PHOMA DISEASE OF WESTERN WHEAT-GRASS

Western wheat-grass, *Agropyron smithii* Rydb. is a very important forage plant in many of the pastures in the Salt Lake Valley,

and any disease which would tend to limit its growth might be considered as being of economic importance. During the past season the writer has collected at a number of points within the Salt Lake Valley specimens of this grass on which there was found a *Phoma* which seems not to have been heretofore recorded as occurring on it.

The species of *Phoma* under consideration does not seem to agree with any of the species described as occurring on various species of Gramineæ. A review of the literature indicates that a considerable number of species of *Phoma* have been found on the Gramineæ but many of them are imperfectly described, so that it is difficult to tell whether the species of *Phoma* occurring on Western wheat-grass is or is not new. In some respects it resembles *Phoma lophio stomoides* Sacc., although the spores are smaller, being as a rule less than 15 μ in length; rarely spores of 15 μ or over are found. Owing to the size of the spores and other prominent characters it is possible that the species is new. A more extended note will be published later.

P. J. O'GARA

SALT LAKE CITY, UTAH,
September 23, 1915

A FUNGUS OF UNCERTAIN SYSTEMATIC POSITION OCCURRING ON WHEAT AND RYE

FOR some time the writer has been studying a very interesting organism which has been found occurring on wheat and rye. Specimens of wheat and rye infected with the organism have been collected at various points in the Salt Lake Valley. The fungus seems to attack the heads of both wheat and rye some time before they emerge from the sheaths. Very often the heads are so severely attacked as not to emerge but remain permanently within the sheath. The fungus is usually found on the rachis, the glumes, the essential organs and the inner parts of the sheaths. At no time has it been found to occur on the internodes below the upper node. The effect upon the inflorescence seems to be such as to prevent the normal development of the essential organs.

The organism was readily isolated and has been grown in pure culture for several months. It grows readily in agar, potato, rice and other media producing normal mycelium and fruiting bodies. The mycelium is white or hyaline, multi-septate and much branched, varying from about 2.5 to 5.8 μ in thickness. Perithecia-like bodies are borne on either short or long stalks on the mycelium or they may be borne terminally. Generally they are found singly but often are more or less grouped. These bodies are from 9 to 17.5 μ in diameter, being spherical or slightly oval, brown to dark brown in color and containing small refractive bodies 2.5 to 5.8 μ in diameter held in a more or less granular mass. The number of refractive bodies may vary from 1 to 6, there being no seeming regularity in number. The walls of the perithecia-like bodies are $\frac{1}{2}$ μ or less in thickness and can be readily separated from the contents, leaving the contents virtually intact.

In some respects this fungus bears a striking resemblance to *Endomyces mali* Lewis.[1] However, no sporidia are produced and the perithecia-like bodies do not contain germinating ascospores. It is therefore only the general appearance of the fungus in culture that bears a resemblance to the perithecia-bearing mycelium of *Endomyces mali*. The perithecia-like bodies of this apparently new organism are produced singly or on short branches of the mycelium or terminally without the fusion of cells or nuclei. When the perithecia-like bodies are placed in culture media germination follows within a very short time, producing a vigorous mycelium which in turn produces perithecia-like bodies in about 5 to 7 days, depending upon temperature conditions.

It has not been determined as yet what may be the function of the refractive bodies generally found in the perithecia-like structure. It is possible that these bodies may be storage material inasmuch as they have not been seen to germinate. Undoubtedly a considerable amount of cytological work must be done in order to determine the systematic position of the fungus. This work is in progress and at

[1] Bulletin No. 178, Maine Agricultural Experiment Station, April, 1910.

a later date a more extended account of the fungus will be given. P. J. O'Gara

Salt Lake City, Utah,
September 23, 1915

THE MEETING OF SECTION C AT THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION

The first session was held on the afternoon of Friday, December 31, in Chemistry Hall, Ohio State University, Vice-president William McPherson in the chair, with an attendance of about 70, practically all from the immediate vicinity of Columbus. The following officers were elected:

Vice-president and Chairman of the Section—Julius Stieglitz, Chicago.

Member of Council—W. Lloyd Evans, Columbus.

Member of General Committee—M. T. Bogert, New York.

Member of Sectional Committee—A. A. Noyes, Boston.

The following papers were read:

"Some Interesting Physical and Chemical Properties of Clays" (illustrated by experiments), by Arthur S. Watts.

"The Contributions of Chemistry to the Production and Preparation of Human Food," by John F. Lyman.

"The American Chemist and the War's Problems," by James R. Withrow.

At six o'clock the members present enjoyed a very pleasant dinner in the Ohio Union. This was followed at 8 o'clock by a session, attended by about 200, at which Dr. Frank K. Cameron gave an address entitled "The Fertilizer Resources of the United States."

John Johnston,
Secretary of Section C

THE MATHEMATICAL ASSOCIATION OF AMERICA

On December 30 and 31, 1915, there was held at Columbus, Ohio, the organization meeting of a new mathematical association, the call for which had been signed by 450 persons representing every state in the Union, the District of Columbia, and Canada. The object of the new association is to assist in promoting the interests of mathematics in America, especially in the collegiate field. It is not intended to be a rival of any existing organization, but rather to supplement the secondary associations on the one hand, and the American Mathematical Society on the other; the former being well organized and effective in their field, and the latter having definitely limited itself to the field of scientific research. In the field of collegiate mathematics, however, there has been, up to this time, no organization and no medium of communication among the teachers, except the *American Mathematical Monthly*, which for the past three years has been devoted to this cause. The new organization, which has been named the Mathematical Association of America, has taken over the *Monthly* as its official journal.

There were 104 persons present at the organization meeting. The constitution and by-laws together with a full report of the proceedings will be published in the January issue of the *Monthly*. The following officers were elected:

President, Professor E. R. Hedrick, University of Missouri.

First Vice-president, Professor E. V. Huntington, Harvard University.

Second Vice-president, Professor G. A. Miller, University of Illinois.

Secretary-Treasurer, Professor W. D. Cairns, Oberlin College.

Publication Committee, Professor H. E. Slaught, University of Chicago, managing editor, Professor W. H. Bussey, University of Minnesota, and Professor R. D. Carmichael, University of Illinois.

These officers, together with the following, constitute the executive council:

Professor R. C. Archibald, Brown University; Professor Florian Cajori, Colorado College; Professor B. F. Finkel, Drury College; Professor D. N. Lehmer, University of California; Professor E. H. Moore, University of Chicago; Professor R. E. Moritz, University of Washington; Professor M. B. Porter, University of Texas; Professor K. D. Swartzel, Ohio State University; Professor J. N. Van der Vries, University of Kansas; Professor Oswald Veblen, Princeton University; Professor J. W. Young, Dartmouth College; Professor Alexander Ziwet, University of Wisconsin.

SCIENCE

FRIDAY, JANUARY 28, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ISTHMUS OF PANAMA IN ITS RELATION TO THE ANIMAL LIFE OF NORTH AND SOUTH AMERICA[1]

IT is a commonplace of geological teaching that the past can be understood only through a knowledge of the present and it is equally true that the present can be fully comprehended only through a knowledge of the past. Each must be employed to elucidate the other and we must pass from one to the other, as new discoveries are made in either realm.

The problems which deal with the existing geographical distribution of animals have received much light from the progress of paleontological discovery and the present arrangement is clearly seen to be the necessary outcome of an illimitable series of past changes, climatic, geographical and biological. Even in pre-Darwinian days the geographical distribution of animals had been given much attention, as a collection of interesting facts, though, under the belief in special creation then prevailing, no explanation of those facts was possible. The general adoption of Darwin's views immediately placed the subject in a new light, for it was at once seen that, unless the theory of evolution could offer a rational and satisfactory solution of these problems of distribution, the foundations of the theory would be greatly weakened.

No result of paleontological studies has, of late years, been more striking than the clear recognition of the fact that migra-

[1] Lecture before the American Association for the Advancement of Science at its San Francisco meeting, August, 1915.

tions from continent to continent have played a highly significant part in bringing about the present geographical arrangement of animals and plants. This conception was first suggested by Cuvier, who, however, would seem not to have attached great importance to it, and it fell into neglect together with his theory of Catastrophism. Present geographical distribution is, when well understood, in itself a partial record of those past changes, partial, because of the extinction of many forms which, in every region, once existed, but have completely vanished. Such migrations from continent to continent were, it should be distinctly understood, radically different in character from the annual migrations of birds, and it is unfortunate that the same term should be used to designate such very distinct classes of facts. The so-called migrations with which we have to deal, such as those of mammals, are a purely unconscious and unintentional spread into new areas, as the increasing number of individuals of a given species begin to press upon the sources of food-supply. This spread will continue from generation to generation until insuperable barriers are encountered and there the spread must cease, unless some geographical or climatic change should remove the barrier, when the spread will continue. For nearly all land animals the most impassable of barriers is the sea, even in narrow arms, though the climatic factors of temperature and, in somewhat less degree, moisture are of almost equal importance. In the long course of geological time and even in its later portion, with which we are here more particularly concerned, both the relations of the various continents to one another and climatic conditions have undergone great and repeated changes, and it is those changes, with their consequently varying possibilities of intermigration, which are registered in the geographically composite fauna of almost every great land area of the earth. Enough has been already learned regarding the history and development of the various mammalian groups to make it plain that the mammals of each different continent form a sort of mosaic, the parts of which are of the most diverse places of origin and dates of immigration. The geological date largely determines the amount and kind of modification which the creatures have undergone in their new homes.

In attempting to estimate the significance of these facts, one assumption must be made, an assumption for which there is a large and increasing body of evidence, namely, that, in the higher animals at least, the same group never originated independently, from ancestors either similar or different, in two disconnected regions. It is perfectly true that parallel and convergent modes of development have always been important factors in the evolutionary process, and no one is more firmly persuaded of this than the paleontologist, but there is no reason to believe that these modes of development ever went so far as to produce substantially identical results in separate land areas. These principles are best illustrated by the mammals, simply because the past geological history of that group has been ascertained more fully and continuously than that of any other class of animals.

The scheme for dividing the land surface of the globe into zoological regions, in accordance with the distribution of animals and especially of mammals, has been the subject of much controversy, but now a general agreement has been reached. Thus, the very long isolation of Australia is recognized by setting off that continent and its adjoining islands, in contradistinc-

tion to all the rest of the world; it is the empire of marsupials and monotremes, while the other continents together constitute the empire of the placental mammals. This placental empire is, in turn, very unequally divided into two realms; the first, called *Arctogæa,* comprises North America, Europe, Asia and Africa and has an unmistakable general similarity in its mammals, in contrast to the second realm, *Notogæa,* which includes South and Central America and the West Indies. After Australia, Notogæa is zoologically the most peculiar region of the earth, a peculiarity which is likewise due to its long separation from the continents of Arctogæa.

The frequently made and interrupted communication of North America with the eastern hemisphere, principally by way of a land which occupied the site of the present shallow Bering Sea, is reflected in the geographically composite character of its mammalian fauna. This connection allowed intermigrations of animals between the eastern and the western hemispheres, each furnishing to the other elements which still persist in their new homes, though often becoming extinct in their places of origin. For example, the horses and camels have disappeared from North America, although they passed through the greater part of their development in that continent. The last of these migrations, which took place in the Pleistocene epoch, brought in such a host of Old World types, that the northern half of North America, comprising the Arctic and Boreal Zones of Merriam, belongs zoologically to the great Holarctic Region, which includes Europe, northern Africa and all of Asia except its southern peninsulas and thus encircles the earth.

The characteristic part of North America is the Sonoran Region, roughly the United States and the Mexican plateau, and ever this region contains many Old World forms, immigrants which arrived here at very different geological dates and, in accordance with the length of their stay here, have become more or less extensively modified. With these are associated many indigenous types, derived from a long North American ancestry and a very few migrants from South America, the short-tailed porcupine, probably the opossums, and in southeastern Texas an armadillo. These southern animals are the insignificant remnant of a great immigration which entered North America from the south, but was not able to gain a lasting foothold here.

South American mammals are obviously divisible into two radically different assemblages, one of which is related to the types characteristic of Arctogæa and the other is entirely peculiar to Notogæa. The first, or immigrant, assemblage comprises all the beasts of prey, the wolves, cats, otters, skunks and one species of bear; all of the hoofed animals, the tapirs, peccaries, deer, and that remarkable section of the camel family, the guanacos, llamas, etc.; among the rodents, the rabbits, squirrels, rats and mice. The second, or indigenous, series includes the opossums, the highly characteristic edentates, sloths, armadillos and anteaters, and a very large number of peculiar rodents, all of which belong to the porcupine group, tree-porcupines, chinchillas, cavies, water-hogs, etc., etc. The paleontological history of South American mammals amply justifies the distinction of these two assemblages as immigrant and autochthonous and shows that South America derived from the north a much larger proportion of its modern mammals than North America did from the south.

It is altogether probable that in the Mesozoic Era all of the continents were

directly or indirectly connected with one another, though it is not necessary to suppose that these connections all existed at the same time. In the Cretaceous Period every continent, even Australia, had its Dinosaurs, huge, slow-moving, land reptiles, which could not have crossed wide arms of the sea, but were dependent for their spread upon continuity of land. It may likewise be assumed that the minute and primitive mammals of the Mesozoic had a similar, world-wide distribution, though the data are still too scanty to permit any positive statements with regard to them. Early in the Tertiary Period of the Cenozoic Era, South America was completely cut off from any land communication with North America, assuming that such communication had previously existed, as it probably had. Thenceforward and for a very long period of time, the faunas of the two American continents developed in entire independence of each other and with remarkably different results.

To the student who is familiar with the Oligocene and Miocene mammals of the northern hemisphere, it is like entering a new world, when he begins to examine the mammalian faunas of the Deseado and Santa Cruz formations of Patagonia. In any comparison between the homotaxial faunas of North America and Europe, the differences are in species and genera, less commonly of families, but between South America and the northern hemisphere it is mainly a difference of orders. These Patagonian faunas contain no Carnivora, Artiodactyla, Perissodactyla or Proboscidea, the groups which were most abundant in Arctogæa. Beasts of prey were numerous and varied, but they were all predaceous marsupials; two other groups of marsupials, the opossums and cœnolestids, were also common, at a time when the whole order had vanished from the northern hemisphere, apparently even from North America. An extremely abundant, diversified and conspicuous element of the fauna, especially in the Santa Cruz and subsequent formations, was the characteristic South American order of the Edentata, which included the ground sloths, armadillos and glyptodonts, none of which appeared in the northern hemisphere till a long subsequent period, with the doubtful exception of the armadillos. True sloths and anteaters have also been reported by Ameghino from the Santa Cruz, and although the evidence for this determination is insufficient, it is altogether probable that these groups were already in existence in the forested regions of the north, if not on the plains of Patagonia, which would seem to have had but few trees at that time. At all events, arboreal animals are rare or absent from the fauna.

The very large assemblage of hoofed animals all belonged to groups which are now altogether extinct and no member of which has ever been found outside of South and Central America, the toxodonts, typotheres, homalodotheres, astrapotheres and litopterns, a wonderful series, which took the place of the hoofed mammals of Arctogæa and would appear to have been strictly autochthonous. Aside from the Insectivora, which, as being of great geological antiquity and nearly cosmopolitan in their distribution, have little bearing on the problems with which we are now concerned, only two mammalian orders occurred in the Santa Cruz fauna which at the same time existed in the northern hemisphere, the rodents and the monkeys. The remarkably diversified and numerous rodents all belonged to the Hystricomorpha, or porcupine-group, of which North America never had a representative until the coming in of the great immigration from the south and to-day has only the short-tailed porcupine. South

America then had no hares, rabbits, pikas, squirrels, marmots, beavers, rats or mice, but in place of them had a host of cavies, chinchillas, agoutis, and several other families, all of which still abound in the southern continent. The South American monkeys present a problem of much difficulty; all our present knowledge justifies us in saying that they could not have come from North America, for that continent never had any monkeys and even the lemurs became extinct here after the Eocene.

The Miocene faunas of North America a e in the sharpest possible contrast to those of South America. They contained several families of true Carnivora, wolves of many diverse kinds, saber-toothed tigers and true cats, weasels, martens, otters, raccoons, and the like; a great abundance and variety of hoofed animals belonging to the artiodactyls and perissodactyls, horses, tapirs, rhinoceroses, chalicotheres, peccaries, camels, llamas, deer, antelopes and certain families, such as the highly characteristic oreodonts, which are now extinct, while the earliest of American mastodons had already made their way in from the Old World. The rodents, though including some very bizarre forms, now extinct, all belonged to the familiar northern families, rabbits, squirrels, marmots, beavers, pocket-gophers, jumping mice, kangaroo rats, vesper mice, etc., etc. There were no marsupials, edentates (with an exception to be noted subsequently), monkeys, rodents of the southern families, nor any of the remarkable hoofed animals which then swarmed in such multitudes in South America. Nothing could be more obvious or more assured than the conclusion that the two Americas had long been so completely separated that no migration of land animals from one to the other was possible and, in this long interval, the operation of divergent evolution had brought about this total disparity and unlikeness of faunas.

The junction of the two Americas, by way of the Isthmus of Panama, would seem to have been effected early in the Miocene epoch, or possibly even at the close of the Oligocene, and then began the slow process of the intermigration of land animals in both directions. The earliest indication of the animal of Notogæan forms in North America is the claw of a ground-sloth, discovered by Sinclair in the middle Miocene of Oregon but it was not till the Pliocene and, more strikingly, in the Pleistocene, that the southern immigrants arrived in large numbers, and in South America no northern types have been found in beds older than the Paraná formation, which I believe to be Pliocene, but which may prove to belong to the later Miocene.

As thus recorded, the process of mammalian diffusion might seem to be incredibly slow, but there are several considerations which help to explain the extreme tardiness with which the exchange of animals between the two continents was carried on. (1) The Miocene mammalian faunas which have as yet been recovered are in the far north and the far south and we know nothing of the intermediate regions, Central America, northern and middle South America. (2) As previously pointed out, the so-called migration of mammals is merely a gradual spread, a wider and wider range, as increasing numbers demand fresh sources of food. (3) For a considerable period after the upheaval of a sea-bottom into land, it must remain impassable to most mammals, because devoid of vegetation, and until plants have taken possession of it, it can serve as only an imperfect and difficult means of communication. (4) Another and very important obstacle to migration between the Americas was that it took place along the lines of longitude

and thus encountered differences of climate, which are among the most effective barriers to the spread of mammals, while between North America and the Old World the migrations followed the lines of latitude and therefore, to all appearances, were accomplished much more quickly. (5) Finally, it is not to be supposed that the fossils already discovered make up anything like a complete list. Doubtless, many things still remain to be found, and others, because of rarity or some other unfavorable circumstance, failed altogether of preservation, and the actual progress of diffusion may well have been more rapid and effective than the observed facts would lead us to suppose.

In the middle and later Pliocene and still more in the Pleistocene the intermigration had proceeded so far that the two continents possessed a very considerable number of mammalian genera in common, as immediately appears from a comparison of the faunal lists. The movement culminated in the Pleistocene, where the number of southern forms in the northern continent and of northern forms in the southern lands reached its maximum. In both continents the Pleistocene mammalian fauna was a very much richer and more varied assemblage than the modern one, for the great and mysterious extinctions which came late in the epoch and at its close, devastating more than three fifths of the land surface of the earth, were especially severe in North America and left that continent in a zoologically impoverished state. Beside almost all of the existing mammals which still continue to inhabit the region, Pleistocene North America had mastodons, three species of elephants, several tapirs and ten species of horses, ranging in size from small ponies to species which exceeded the largest modern draught horses. Peccaries spread as far north as Pennsylvania and from ocean to ocean and were accompanied by great herds of camels and llamas. Seven species of bison, some of them far surpassing the existing buffalo, so-called, were distributed from Florida to Alaska, while musk-oxen and allied forms extended far to the south and along the Pacific coast into California. Modern types of deer and antelopes were associated with several extinct types, some of which must have been very grotesque in appearance. Especially remarkable is the discovery by Gidley in western Maryland of an antelope which is hardly distinguishable from the recent African Eland. Almost all the existing North American beasts of prey have been found in the Pleistocene, but there were many more that are now extinct and were of extraordinary size and power; giant wolves, lions, the terrible saber-toothed tigers and the huge short-faced bears are examples of these vanished forms, the disappearance of which made life much easier for early American Man.

All of the animals so far enumerated are typically Arctogæan in character and were either immigrants from the Old World, of various geological dates of arrival, or were of indigenous North American ancestry and development, but mingled with those were many South American mammals, the history and evolution of which can be followed in satisfactory detail in the successive Tertiary formations of that continent. The strangest and most conspicuous of those migrants from the south were the great edentates. The huge, elephantine ground-sloths, a group now entirely extinct, but very abundant in the Pleistocene of both North and South America, ranged all across the continent from Pennsylvania to California. The genus *Megalonyx*, which, it is interesting to note, was first named by Thomas Jefferson from some bones found in Virginia, would seem to

have been a forest-living creature, and, so far as is now known, was confined to the region east of the Mississippi River. The almost equally massive *Mylodon* replaced it over the Great Plains and on the Pacific coast, particularly fine specimens occurring in the wonderful asphalts of Rancho la Brea, which the work of Professor J. C. Merriam has rendered so celebrated. A third genus, *Megatherium*, of even greater size and heavier proportions, extended into Georgia and South Carolina, but is not known farther north, as it was probably unable to endure a cold climate. Those most grotesque beasts, the Glyptodonts, which were like enormous armadillos in appearance, accompanied the ground-sloths in their migration to North America, but have been found only in the southern states, from Florida to Texas and Mexico, being doubtless limited in their northward range by the barrier of climate.

The Pleistocene rodents tell a similar story. Practically all of the modern forms were already here and associated with these were certain strange and curious forms, like the giant beaver, of northern origin, but now extinct, and a few South American immigrants, like the short-tailed porcupines and the water-hogs, of which only the former have survived. The marsupial group of the opossums had in the Eocene epoch extended over Europe and the Americas, but none have been found in North America in beds later than the Oligocene. Of course such small animals may have merely escaped the collector's eye, but, taking all things into consideration, it is probable that the group vanished completely from the northern hemisphere and returned with the immigration from South America, where they had continued to flourish without interruption.

The Pleistocene fauna of South America was likewise much richer and more varied, especially in very large mammals, than is the existing one, and is far stranger than the corresponding one of North America, differing more radically from that of modern times, for the extinctions swept away not only species and genera, but whole families and orders as well. The pampas of Argentina, the caverns of Brazil and, in lesser degree, areas in Bolivia and Ecuador, have yielded a marvelous series of Pleistocene mammals, which give a very striking picture of the life of the times. The same distinction between immigrant and autochthonous types which was noted in the existing fauna of South America was as strongly marked in the Pleistocene. Beside those northern immigrants which have maintained their foothold in the southern continent and are represented there to-day, there are many others which are now extinct, some of those groups which have become altogether extinct, others which have vanished from the western hemisphere, or from South America only. The Pleistocene fauna had substantially all of the mammals which still inhabit Notogæa and it is therefore unnecessary to repeat the names of those which form part of the modern fauna. It may be noted, however, that some of the recent families had representatives much larger in size than any that now exist, such as the monkeys and the raccoons, above all, the armadillos.

Some of these extinct immigrants were very abundant and conspicuous in the Pleistocene. The great saber-toothed tigers ranged all the way from Pennsylvania and California to the Argentinian pampas and were accompanied by the short-faced bears. A strange feature was the presence of a wolf which is apparently referable to the same genus (*Cyon*) as the wild dog or Dhole, of recent India. Horses were very common wherever Pleistocene fossils have

been found and must have arrived in South America at a relatively early date, for several highly peculiar and aberrant types were developed. One of these (*Hyperhippidium*) found in the Andes, was a small, mountain horse, with remarkably short feet which were well adapted to climbing. Tapirs ranged down into Argentina, much farther south than at present, but were not otherwise noteworthy. The range of the llamas also was much greater than it is to-day; now, they are restricted to the colder parts of the continent, but in the Pleistocene they extended into the forests of Brazil. Two antelopes have been reported, a family of which Notogæa has now no representatives. Mastodons of several species have been found in many parts of the continent, but, curiously enough, the true elephants did not accompany them in their southward migration. Why this was, it is difficult to say; perhaps because the North American elephants, which came in by way of Siberia, were cold-country species and therefore unable to cross the tropics.

The Pleistocene extinctions worked even greater havoc among the autochthonous forms than among the immigrants, destroying almost all of the very large mammals whose history and development may be traced back, step by step, through the successive divisions of the South American Tertiary. The visitor to the museums of La Plata and Buenos Aires can not but be deeply impressed by the number and variety of the ground-sloths and glyptodonts from the Pampean formation which are there displayed; it is immediately evident that the members of those groups which inhabited Pleistocene North America were but the outlying stragglers of the far more numerous and incomparably more diversified assemblage found in South America. They were indeed a strange and grotesque host of ponderous, slow-moving, but inoffensive plant-feeders, which, together with the almost equally bizarre indigenous hoofed animals, gave a most outlandish character to the fauna. The ground-sloths ranged in size from a tapir to a short-legged elephant; *Megatherium* even surpassing the elephants in massiveness of trunk and limbs. The glyptodonts differed much among themselves in size, in the character of the head, in the form of the solid and heavy carapace, but especially in the armature of the tail, which, in some cases at least, must have been a formidable weapon of defence. It is usual to call the glyptodonts "giant armadillos," but that term is more properly applied to certain huge animals, as large as a rhinoceros, which were true armadillos. The largest existing species of the group is hardly more than a yard long.

Among the hoofed animals, three of the native groups, the toxodonts, typotheres and litopterns, which were so remarkably abundant and varied in the Santa Cruz Miocene, persisted into the Pleistocene and then became extinct. Evidently they had begun to decline long before that epoch, possibly because of the competition of the more advanced and highly organized intruders from the north, though certain series continued to progress in size and differentiation of structure until the end of their career. One of the most characteristic of these animals was *Toxodon*, of which two skeletons are mounted in the La Plata Museum. The genus was found by Charles Darwin, who says of it: "Perhaps one of the strangest animals ever discovered; in size it equalled an elephant or megatherium, but the structure of its teeth, as Mr. Owen states, proves indisputably that it was intimately related to the Gnawers [*i. e., Rodentia*] . . . in many details it is allied to the Pachydermata: judging from

the position of its eyes, ears and nostrils, it was probably aquatic, like the Dugong and Manatee, to which it is also allied." Darwin's scanty materials led him to exaggerate the size of this extraordinary beast and his views as to its diverse relationships are not tenable from the modern point of view, but his brief description brings out the strangeness of structure in a vivid way. *Toxodon* ranged as far north as Nicaragua, but, so far as is known, did not enter North America proper.

Somewhat distantly related to *Toxodon* was the equally strange *Typotherium*, an animal of moderate size, which was the last of a very long series of native developments. Its permanently growing, chisel-like incisors are so similar to those of the rodents that the genus was long referred to that order. Typotheres were extremely numerous in the Santa Cruz times, but declined rapidly in relative importance after that and disappeared completely at the end of the Pleistocene.

Of all the many bizarre animals which swarmed in Pleistocene South America, none was more extraordinary than *Macrauchenia*, which, like *Toxodon*, was one of Darwin's discoveries, when he was on the memorable voyage of the *Beagle*. *Macrauchenia* was somewhat like a large camel in proportions, but of much heavier build. The head was relatively small and must have had quite a long proboscis, which added much to the grotesque appearance of the creature. The neck was very long, suggesting that the animal browsed upon trees, which is also indicated by the character of the teeth; the legs were long and heavy, the feet short and each provided with three toes. This was the last of the Litopterna, an exclusively South American group which had for a long period played a very conspicuous rôle in that continent, but, like the typotheres, had begun to decline in numbers after the Santa Cruz epoch.

The rodents of the South American Pleistocene do not offer much that is of particular interest. The presence of North American types of meadow-mice, which no longer exist in the southern continent, is a noteworthy fact, as is also the occurrence of *Megamys*, an extinct representative of one of the indigenous families. This was the largest of all known rodents, living or fossil, and rivalled the rhinoceros in size—for a rodent, a veritable monster.

From this comparison of the North and South American faunas, as they are revealed in the geological succession, certain facts stand out saliently. (1) It is evident that North America contributed much more extensively to the southern fauna than South America did to the northern. Even in the Pleistocene, when the movement of intermigration had reached its maximum and there were more mammalian types common to the two continents than at any other period, before or after, the number of Notogæan types found in North America was really very small; opossums, a few rodents, ground-sloths and glyptodonts complete the list. Of these only the opossums and the short-tailed porcupines have survived to modern times. On the other hand, the list of northern forms which, before or during the Pleistocene epoch, had invaded the southern continent, is very much longer; bears, cats, saber-toothed tigers, weasels, otters, skunks, raccoons, dogs of many kinds, rabbits, squirrels, rats, mice, horses, tapirs, peccaries, deer, antelopes, llamas and mastodons, all found their way into South America and most of them still inhabit that region. The short-faced bears, saber-toothed tigers and the mastodons became extinct everywhere; the horses died out completely in the western hemisphere, while the ante-

lopes and meadow-mice vanished from South America, though persisting in North America. The permanent contribution of South America to the northern fauna is, on the contrary, quite insignificant.

While it is impossible to say with any certainty just why the northern animals should have thus predominated over the southern, it is reasonable to conclude that it was due to the higher stage of intelligence and structural development which the former had attained. There can be no question as to this structural superiority, but such superiority, as we call it, does not always insure victory in the struggle for existence, victory largely depending upon the nature of the environment. It must be remembered that by no means all of the northern animals which invaded Notogæa were of North American origin; many were immigrants from the Old World, of different geological dates of arrival in the western hemisphere and correspondingly different degrees of modification. The repeated junction of North America with Asia made the former a part of Arctogæa, incomparably the greatest land area of the globe, and such immensity of connected lands is favorable to the higher evolution of terrestrial life. The comparative isolation of South America kept that continent in a relatively backward state.

(2) The very different degrees of likeness and unlikeness between the faunas of the two continents in the successive geological epochs point unmistakably to extensive geographical changes. Beginning with a time of radical difference, when the two faunas had almost nothing in common, the story goes on to tell of a period when an exchange of mammals began, gradually extending until a very considerable number of types common to both continents was found, and finally reducing the number of these common types to the present condition. The obvious interpretation of these facts is that the complete dissimilarity of animals was due to an equally complete separation of the continents and that a certain degree of likeness was brought about when a land connection was established. Well-founded as this conclusion appears to be, confirmation from a quite independent line of evidence would be welcome and such evidence is to be obtained from the geology of Central America and the Isthmus of Panama.

(3) Intermigrations between the Americas have always had to contend with serious obstacles and difficulties; otherwise, the interchanges of land animals would have been much more extensive than they ever became. Then, too, it would seem that there have been times in the past when migration was less difficult than it is at present, for now there is little or no indication of such movements. As was previously shown, the principal barrier to the spread of mammals over connected or continuous lands is climate, and it follows that the times of migration were those of more favorable climatic conditions. In the early Miocene, when the migrations probably began, the climate was much milder than at present, with less difference between the tropical and temperate regions. Through nearly the whole of the Tertiary period these conditions persisted, though with a slowly progressive refrigeration, and even in the Interglacial of the Pleistocene, the amelioration of climate was such that migration was rendered more practicable than it is under existing circumstances.

The geological structure and history of the lands around the Caribbean Sea are not nearly so well known as would be desirable, but certain very significant facts have already been ascertained. Especially is this true of the Isthmian Canal Zone,

which has been studied by Macdonald. There is very little direct information, as yet, regarding the condition of Central America and the Isthmus of Panama during the Eocene, whatever rocks there may be in the region of Eocene or earlier date being buried under newer formations. It is clear, however, that in the succeeding Oligocene epoch the whole Caribbean region was extensively submerged; the Greater Antilles were much reduced in size and nearly the whole of Central America was under water, a broad sea separating North and South America, though doubtless with scattered islands. On the Caribbean side of the Isthmus is a very thick mass (estimated at 2,500 feet) of Oligocene strata, the Gatun formation, which is crowded with marine fossils. The Culebra Hills, through which the great cut has been made, are chiefly built up of volcanic materials, lava streams, mud-flows, tuffs, etc., in a very complicated arrangement, and running through the cut may be traced thin bands of a marine limestone, which carry Oligocene fossils. The evidence of submergence is thus complete, but the date of upheaval can not be very definitely fixed. Except for a narrow strip of Pleistocene on the Caribbean coast, no marine rocks later than the Oligocene have been found on the Isthmus and it would be natural to conclude that the elevation came at the close of that epoch. Some allowance must, however, be made for erosion and it is quite possible that early Miocene rocks were formed and have since been swept away. The ground-sloth in the middle Miocene of Oregon is proof that the connection was established at least as early as that.

In the Pliocene and perhaps early Pleistocene the isthmian region was considerably broader than it is now and it is probable that the flat lands lying along the then existing coast afforded a comparatively easy highway of migration, the chief obstacles to which were climatic rather than topographical, but during some part of the Pleistocene the Isthmus was again depressed and narrowed even beyond its present limits, as is shown by the fringe of marine deposits along the Caribbean coast.

Central America, like the West Indies, belongs zoologically to South America and forms a part of the Neotropical Region. This fact is not altogether easy of explanation. It may be that the Isthmus connected South and Central America at a time when the latter was still separated from the northern continent. Were this the case, the southern fauna would have had the advantage of possession, when the northern invasion began. On the other hand, the cause may be entirely climatic and that this is the rightful conclusion is indicated by the distribution of animals now obtaining in Mexico. The high table-land of that country contains an extension of the North American fauna, while the tropical lowlands are South American.

It is a truism to say that the Isthmus of Panama is the strategic key to the zoological relations of North and South America, and yet it was not necessarily so, as other lines of communication might conceivably have been established. So far as our knowledge extends, however, the geographical events in the history of the Isthmus dominated the biological interrelations of the continents which it now unites. When the Isthmus was submerged, South America was in a state of nearly or quite complete isolation and developed a highly peculiar fauna, few elements of which were shared with any other continent, and which was as unique in its way, though on a higher plane, as is the Australian. It was, so to speak, a highly interesting experiment in evolution; a great continent,

with varied climate and a great diversity of conditions, mountains and valleys, forests and open plains, left through long ages entirely to its own resources, was the closed arena of rapid development divergent from the rest of the world. The result is plainly obvious now. Though the elevation of Central America and the Isthmus into land joined Notogæa with the northern continent and the way of migration thus opened led to an extensive infusion of northern elements in the southern fauna, South America still remains, after Australia, the most peculiar region of the earth.

North America had quite a different fate; its connection with the south was a mere episode which led to the transitory reception of a considerable number of Notogæan forms and the permanent establishment of a very few. Its oft-repeated connection with the Old World was far more significant from the zoological point of view, for that maintained the essential community of mammalian life all over the northern hemisphere. To this connection it is due that North America is a part of Arctogæa and that its Arctic and Boreal zones are inseparable from the great Holarctic Region of Europe and Asia. In the Pliocene and Pleistocene, North America was the meeting-ground of currents of migrating animals, from the west and from the south and for a time the fauna was of an exceptionally composite character, Old World and Notogæan elements mingling with the richly variegated indigenous stocks. But this condition was much modified by the Pleistocene extinctions which almost entirely exterminated the invaders from the south and greatly reduced the number of autochthonous forms. The destruction of immigrants from the Old World was less extensive and thus the zoological relations of North America in the Pliocene and Pleistocene were quite different from what they are now.

The problems which deal with the possible connections of South America with continents other than North America and especially with Africa and Australia, are extraordinarily interesting from many different points of view, but there is no time to enter upon a discussion of them here, nor are they altogether germane to the subject before us, which is the zoological relations of the western hemisphere as conditioned by the Isthmus of Panama and its geographical history.

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THE NEEDS OF APPLIED OPTICS[1]

We have formed this Association for the Advancement of Applied Optics because we believe that the interests of all branches of applied optics may be materially furthered by such an organization. It seems fitting, therefore, to devote this first meeting to a discussion of the needs of applied optics and to the outlining of plans for securing the advancement desired.

The interests of every one who uses light are affected by applied optics in its broader interpretation. In the formation of this society we have invited the cooperation of all who are directly interested in the study and use of light and of optical instruments of all kinds. We therefore include, among those whose interests we aim to serve, astronomers, designers of optical instruments, illuminating engineers, photographers, ophthalmologists, photometrists, colorists, petrologists, microscopists and all investigators of optical problems. The field to be covered is broad and the interests affected many and diverse.

[1] An address inaugurating the formation of the Association for the Advancement of Applied Optics delivered at the first meeting held in Rochester, January 4, 1916.

Beyond question, the greatest present need of applied optics is cooperation. Workers in one field are often lacking in knowledge of the data, methods and principles developed by those in other fields. For example, the illuminating engineer desires more complete information relating to photometry, radiation laws, scattered light, and above all on the properties of the retina upon which depend the conditions for best illumination. Such information is difficult to obtain in any case and much of it is not available at all. Again, either the eye or a photographic plate is an essential part of every optical instrument, yet what designer of optical instruments posesses a full knowledge of the characteristic properties of either? The ophthalmologist desiring to know more of the nature and properties of light is confronted by a highly technical mass of information, largely in mathematical language and almost useless to him. A great many persons, vitally interested in the color of materials, are almost entirely without information as to the precise analysis or synthesis of color. Nearly every one could make good use of a knowledge of the conditions of illumination conducive to the best seeing, yet evidences of profound ignorance of those conditions are on every hand. Similar instances of lack of coordination of interests in applied optics might be multiplied indefinitely.

We believe that such a condition of affairs is best met by the formation of such a society as this. It is our aim to provide for the free interchange of ideas in the meetings of this society. A clearing house and a storehouse of data and information will best be provided by the establishment of a journal for the publication and dissemination of new and useful material in the various fields of applied optics. As soon as such material shall have reached a permanent form, it should be crystallized in convenient books of reference. The need for the organization, the journal, and for reference texts will hardly be questioned by any one.

Aside from the need for cooperation and the dissemination of the knowledge already available in the various fields of applied optics, the great need is for more information along various lines. It is a fitting occasion to briefly review the several branches of applied optics, calling attention to fields of research in which investigation appears to be most urgently needed.

The very ground work of all applied optics is of course pure optics. Little progress can be made without a thorough knowledge of the laws of the refraction, reflection, absorption and emission of light, nor of diffraction, interference, scatter or polarization. Most of these laws are well known and familiar but there are conspicuous exceptions of vital importance in applied optics. The laws of radiation applicable to a perfect radiator are fairly complete but very little is known of the corresponding laws applicable to the practical case of heated bodies or to gases conducting an electric current. While the laws of reflection and refraction are commonly considered well known, as a matter of fact we know almost nothing of the laws applicable to a layer whose thickness is comparable with the length of a light wave. In this case practise has not waited for theory, for lens surfaces are said to have been prepared giving greatly decreased loss of light by reflection. Another and conspicuous gap in our knowledge of pure optics relates to heterogeneous media. Light is scattered by small particles and absorbed by still smaller ones but very little attention has been given to the laws governing the scatter and diffusion of light so important in illuminating engineering.

In the field of lens calculation, though

great results have been achieved, our methods and mathematical tools are those of fifty years ago. We still calculate lenses largely by the cut and try method of triangulating a bundle of rays through the lens and finding whether they meet in the image plane. It is possible that no other method of calculating lenses will ever prove of practical value, yet a number of our ablest mathematical physicists have attempted to apply the best modern mathematical methods to lens design. Their results have been interesting, but of practical value only in limited fields. The consensus of opinion to-day appears to be that if the seven lens aberrations could but be expressed in a suitable mathematical language, they would assume comparatively simple forms readily soluble. It is quite certain, however, that such simplicity is impossible in any of the mathematical systems yet tried, and that the desired result will only be possible in some system not yet invented.

Our next greatest needs in lens design are generalizations and publicity. In every complete set of calculations for a given lens, conclusions are arrived at relating changes in radii, thicknesses, separations and glass indices to variations in the degree of correction, in other words, a set of differentials is obtained, by the laborious methods of ray triangulation. Yet these very valuable results are regularly allowed to go either to the waste basket or to the locked notebook. The renowned Abbe set a worthy example of world-wide usefulness by having prepared and published tables for the selection of companion glasses for telescope objectives, thereby saving others hundreds of hours of labor. If we followed his worthy example, we should publish sets of differentials applicable to each of the important lens types as soon as obtained and thus obviate a tremendous waste of time in duplicating results.

In particular, we need publication and public discussion of such material as general rules for the spectral correction of objectives for photographic and visual purposes, general rules for reducing distortion, for locating and displacing Gauss points, limits of tolerance in definition and resolving power, the best methods of testing objectives and the like.

In the design of optical instruments a similar lack of coordination and generalization is apparent. The instrument-using public has been too often ignorant and always tolerant of defective design. The average user accepts without question, as he is without recourse, instruments hastily conceived and imperfectly worked out in design. Our largest makers employ specialists in the design of each class of instruments. Lesser makers of the less used instruments, such as spectroscopes, photometers and radiometers, seldom have the benefit of the crystallized general opinion of those users of his instruments who know what the performance of a first-class instrument should be. We trust that every class of both user and designer of optical instruments will derive benefits from this organization.

No optical instrument can be of any service without either an eye or a photographic surface as an adjunct. The properties of these should, therefore, be well known to the designer of lenses and instruments as well as to those more directly interested in them. The material of these three chief branches of applied optics (lens design, vision and photography) is, however, widely scattered and few who are well posted in one branch are even well informed in the other two.

The fundamental problem of the photographic surface is the rendering of the light impressed upon it. The quantitative relations between exposure, development and

density of image were obtained by Hurter and Driffield twenty years ago. Since that time much has been found out concerning the nature of the latent image and of development and the conditions which govern speed and density gradient. The greater part of the preliminary work in photographic research may be regarded as complete.

Investigation in photography is now centered upon the more recondite problems and a clearing up of the nature of the photographic processes. We are not yet able to express photographic density as a function of energy, wave-length and time. The relation between plate speed and wave-length is known for but few emulsions. Speed varies with both absolute intensity of radiation and the rate at which it is applied according to laws not yet understood. The maximum density gradient obtainable varies with exposure, wave-length, emulsion and development in ways now being investigated. A knowledge of the resolving powers of the photographic surface, of the eye and of the lens or optical instrument is of the utmost importance to workers in almost every line of applied optics.

The photographic emulsion is optically a translucent medium of high scattering power. The penetration of light into such media varies a great deal with the wave-length of the light, with size of grain and with distance and direction in the medium. Hence, a knowledge of the optical laws governing scattered light is of the utmost importance in photographic research and of such laws but very little is known.

The photographic reactions to light bear a close resemblance in many respects to the reaction of the retina and from the optical properties of the retina much information may be drawn that throws light on the photographic effects and vice versa. Hence, the investigation of the retinal and photographic reactions may very properly be carried on side by side and results obtained in either field applied in the other.

Intimately related to all branches of applied optics are the visual properties of the human eye. Broadly stated, what is known of the eye as an optical instrument constitutes but a rough working knowledge of it. The curvatures, thicknesses and refractive indices of the various eye media in an average normal eye are fairly well known as well as the location of the nodal points and center of rotation. Three of the third order aberrations are important in vision, namely, the spherical aberration, the chromatic variation of the spherical aberration and the axial chromatic aberration. Of these only the last has been studied and measured and that only recently. One remarkable result of these measurements is the discovery that many eyes possess a type of axial chromatic correction previously unknown in lens optics and which probably could not be duplicated in a glass lens. It is to be hoped that methods of measuring the two other aberrations will shortly be devised and applied.

The nature of the reactions of the retina to light have been extensively studied during the last twenty years. But the problems requiring investigation are many and difficult and scarcely more than preliminary results have yet been obtained. The visual impression requires time to originate and grows at a rate varying with both the intensity and wave-length of the light producing it as well as with the previous treatment of the retina. It is no simple matter to isolate and measure these various effects nor to correctly interpret the results obtained.

Most studied and best known is the relative brightness of the same amount of radiation of various wave-lengths, the so-called "Visibility" of radiation. This is a measure of the relative sensibility of the

retina to light of different wave-lengths but of equal energy. This relation is known for a great number of subjects to a quite satisfactory precision. It establishes the ratio of the light unit to the energy unit, hence, is of fundamental importance in illuminating engineering. Strictly speaking, we can neither define nor measure light without it.

When it comes to measuring the light sensation caused by a given light impression, an apparently insurmountable difficulty is encountered, for a sensation can not be directly measured. The sensation is, however, the integral of the sensibility and the sensibility is proportional to the reciprocal of the just noticeable difference in intensity and this may readily be measured. The necessary data are being accumulated and before long we shall be able to formulate the general laws of the visual reaction to light intensity in the case of white light. Similar data relating intensity sensibility to color, intensity and time must next be obtained.

On entering a dark room we become able to distinguish objects after a shorter or longer interval of time depending upon various conditions not yet worked out. Rate of adaptation curves must be determined for all initial conditions of adaptation, not only for white light but more particularly for the reds, yellows and greens used in the safe lights of dark rooms.

Very little is yet known of the relation between visual acuity and the brightness of the object viewed. The ability to distinguish fine details is known to fall off rapidly with decreasing illumination, but we have not the data for the formulation of any laws.

Illuminating engineers require a mass of such data on the properties of the retina, for the eye is the sole means of judging whether lighting is good or bad and the conditions for best seeing have been only very roughly worked out thus far. We require to know what illumination levels and what contrasts are best and what are the effects of excessive contrasts and oblique glare in depressing the sensibility of the retina.

The precise measurement of color is an almost unworked but important field of applied optics. The preliminary part of the work only has been done. The underlying theory has been roughed out, methods have been devised and precision colorimeters designed. But our fundamental color scales have been but partly worked out and the various laws of color combination are practically unknown. The work urgently requiring attention in this field amounts to quite a number of man-years.

Within the necessary limits of this discussion only the more urgent problems in the more important fields of applied optics could be reviewed. The special problems of refractometry, photometry, radiometry, interferometry, spectrophotometry, polarimetric analysis and other fields can not even be enumerated here. It is hoped, however, that this brief outline may have impressed upon us all the necessity for concerted effort in solving the numerous problems which confront us. We trust that the formation of this society will, by promoting team work and well directed research, prove to be a powerful factor in the advancement of applied optics. This city has long been a leader in the production of optical materials, may it become the great source of optical ideas and the recognized home of optical learning. P. G. Nutting

SCIENTIFIC NOTES AND NEWS

Dr. William W. Keen has been reelected president of the American Philosophical Society for 1916. The vice-presidents, Professors William B. Scott, Albert A. Michelson and

Edward C. Pickering have also been reelected.

PROFESSOR R. A. MILLIKAN, of the University of Chicago, was elected president of the American Physical Association at the recent Columbus meeting.

THE officers of the American Society of Naturalists for 1916 are: *President,* Raymond Pearl; *vice-president,* Albert F. Blakeslee; *secretary,* Bradley M. Davis; *treasurer,* J. Arthur Harris; additional members of the *executive committee,* Edward M. East, Henry V. Wilson, Frank R. Lillie. The society has ordered an appropriation of $200 for the Concilium Bibliographicum, Zurich.

NEWS has been received from Sweden that the actual delivery of the Nobel prize in chemistry for 1914, awarded to Professor Theodore W. Richards, of Harvard University, together with the other Nobel prizes for 1914 and 1915, will be postponed until June 1 of this year. The prize-winners are invited to go then to Sweden in person to receive their prizes, and to give their Nobel lectures.

THE Leeuwenhoek medal of the Netherlands Academy of Sciences, awarded to Surgeon-General Sir David Bruce, F.R.S., A.M.S., was presented to him on December 24 by the Netherlands Minister to Great Britain. The medal was founded in 1875, on the occasion of the Leeuwenhoek celebration in Delft, and is presented every ten years. It was awarded to Ehrenberg in 1875, to Ferdinand Cohn in 1885, to Louis Pasteur in 1895, and to Beyerinck in 1905.

DR. LAZARUS FLETCHER, F.R.S., director of the Natural History Departments of the British Museum, has been knighted.

PROFESSOR IRVING PORTER CHURCH will retire from the faculty of the college of civil engineering of Cornell University at the close of the current academic year, when he will be sixty-five years old. The board of trustees has adopted a resolution expressing its sense of the university's debt to Professor Church.

PROFESSOR C. FRANK ALLEN, who has held the chair of railroad engineering in the Massachusetts Institute of Technology since 1887, will retire under the benefits of the Carnegie Foundation at the close of the present academic year.

PROFESSOR R. B. CLINTON, who lately retired from the professorship of experimental philosophy at Oxford at the end of his fiftieth year of service, has been elected to an honorary fellowship at Wadham College.

THE Draper Committee of the National Academy of Sciences has granted $300 to Professor Joel Stebbins, head of the department of astronomy of the University of Illinois, in support of his researches at the observatory. The special work which is now being carried on at the observatory is the improvement of his method of measuring the light of stars, which is being developed in collaboration with Professor Jacob Kunz of the department of physics.

AT its meeting of January 12, the Rumford Committee of the American Academy of Arts and Sciences appropriated the sum of $200 to Professor H. M. Randall, of the University of Michigan, in aid of his researches on the infra-red spectrum, the grant to be used to defray the salary of an assistant.

DR. WILLIAM DEB. MACNIDER, professor of pharmacology at the University of North Carolina, has been notified of an award of $250 by the trustees of the Rockefeller Institute to enable him to continue his research work in pharmacology.

DR. FREDERICK E. DILLEY ('03, Western Reserve), instructor in surgery, Union Medical College, Peking, China, has arrived for postgraduate work in Cleveland until next August.

DR. KARL H. VAN NORMAN, formerly of the Johns Hopkins Hospital and now a captain in the Royal Canadian Army Medical Corps, is in charge of a British hospital division at Ramsgate, England.

DR. HUGH M. SMITH, commissioner of fisheries, was elected honorary president of the Washington Aquarium Society at an organization meeting held on January 21. Other officers elected were: *President,* Dr. R. W. Shufeldt; *First Vice-president,* L. W. Bauer; *Second Vice-president,* Mrs. L. Helen Fowler;

Corresponding Secretary, J. Henri Wagner, and *Financial Secretary* and *Treasurer,* E. S. Schmidt. The following committee was elected to prepare a constitution and by-laws: Dr. Paul. Bartsch, chairman, Miss Mary C. Breen, Mrs. G. H. Burris, W. S. Adams and J. E. Benedict.

An intensive study of the question of pneumonia will be made by a commission appointed on January 11, by Director Wilmer Krusen, of the Department of Health and Charities of Philadelphia. The recent epidemic of grip and pneumonia occasioned the appointment of a commission. Director Krusen appointed the members from those eminent either for clinical work or for their ability as laboratory research workers. The city laboratories will be placed at their disposal. Dr. David Riesman, professor of clinical medicine in the University of Pennsylvania and the Philadelphia Polyclinic, will be chairman. Other members are: Dr. Hobart A. Hare, professor of therapeutics at Jefferson Medical College; Dr. Judson Daland, professor of clinical medicine in the Medico-Chirurgical College; Dr. William Egbert Robertson, professor of the practise of medicine, Temple University; Dr. Randle C. Rosenberger, professor of hygiene and bacteriology in the Jefferson Medical College and the Women's Medical College; Dr. Paul A. Lewis, director of the Ayer Clinical Laboratory of the Pennsylvania Hospital and director of the pathological department of the Henry Phipps Institute, and Dr. John A. Kolmer, professor of pathology, Philadelphia Polyclinic; instructor of experimental pathology at the University of Pennsylvania.

The mental hygiene committee of the New York State Charities Aid Association announces that, in the interest of a state-wide campaign of education for the prevention of insanity, plans have been made for public lectures. Specialists in mental diseases have been appointed to deliver such lectures, including Drs. Stewart Paton, Smith Ely Jelliffe, August Hoch, Thomas Henry Williams, Menas S. Gregory, Charles S. Little, Thiells, William Mabon, James V. May and Herman G. Matzinger.

At the recent biennial convention of the honor society of Phi Kappa Phi, the following officers were elected: *President General,* Edwin E. Sparks, State College, Pa.; *Secretary General,* L. H. Pammel, Iowa State College, Ames; *Treasurer General,* C. H. Gordon, University of Tennessee, Knoxville; *Registrar General,* J. S. Stevens, University of Maine, Orono; *Provincial Secretaries:* Eastern District, J. A. Foord, Massachusetts Agricultural College, Amherst; Southern District, G. H. Boggs, Georgia School of Technology, Atlanta; Northern District, E. N. Wentworth, Kansas Agricultural College, Manhattan; Western District, L. W. Hartman, University of Nevada, Reno. The constitution was revised and other important business was transacted.

Dr. Willis T. Lee, of the U. S. Geological Survey, is giving a course of ten lectures at the Johns Hopkins University on successive Monday and Tuesday afternoons. His subject is "Mesozoic Physiography of the Southern Rocky Mountains."

In the new Bowdoin Union, Bowdoin College, not yet dedicated formally, the first public lecture was given on January 17 by Professor George H. Parker, of Harvard University, who gave an illustrated address on "The Seals of the Pribiloff Islands," under the auspices of the Biological Club.

Dr. K. George Falk, of the Harriman Research Laboratory of the Roosevelt Hospital, delivered a lecture on "The Electron Conception of Valence," before the Chemical Society of the College of the City of New York on December 22.

Dr. Charles H. T. Townsend gave an illustrated lecture on verruga to the students of the medical school of Howard University, Washington, D. C., on January 15.

A memorial of Eustachius was recently unveiled in the great quadrangle of the University of Rome in the presence of the prime minister, the minister of public instruction, the mayor of Rome, and the rector and mem-

bers of the senate of the university. The memorial, which is a bronze tablet attached to one of the pillars of the upper portico, near a marble memorial of Victor Emanuel II., represents Eustachius in his professor's robes in the act of lecturing; he holds in his left hand a human skull and the right arm rests on tables showing the structure of the ear.

JOHN OREN REED, professor of physics in the University of Michigan, and until a year ago dean of the college of literature, science and arts, died on January 23, at the age of sixty years.

CHARLES VICTOR MAPES, an industrial agricultural chemist of New York City, died on January 23, in his eightieth year.

DR. ALFRED J. NOBLE, superintendent of the Michigan State Hospital in Kalamazoo, an authority on insanity, died on January 20, aged fifty-eight years.

THE death is announced at the age of forty-nine years of Professor Donaldson Bodine, who held the chair of geology and zoology at Wabash College.

MR. A. D. DARBISHIRE, lecturer on genetics in the University of Edinburgh, known by his experiments bearing on the laws of heredity, and his book on "Breeding and the Mendelian Discovery," died on December 26, 1915.

MR. H. A. TAYLOR, a distinguished English electrical engineer, known especially for his work on submarine cables, has died at the age of seventy-four years.

DR. FRITZ REGEL, professor of geography at Würzburg, died on December 2, aged sixty-two years.

DR. GEORGE OLIVER, an English physician, known for his valuable researches on the circulation of the blood, has died at the age of seventy-four years.

THE ninth annual meeting of the Illinois Academy of Science will be held at the University of Illinois, Urbana, Friday and Saturday, February 18 and 19, 1916. The program will be as follows:

Friday, 1 o'clock P.M.—Meetings of all committees.
Friday, 2 o'clock P.M.—Business and symposium on astronomy.
Friday, 6 o'clock P.M.—Dinner. Ten minute address upon the work, policy and value of the academy.
Friday, 8 o'clock P.M.—President's address and reception.
Saturday, 9 o'clock A.M.—General papers and sectional meetings.
Saturday, 12 noon—Luncheon.
Saturday, 1:30 o'clock P.M.—Inspection of the university buildings.
Saturday, 2:30 o'clock P.M.—General papers, election of officers and other business.

If papers presented render it advantageous, the academy will be divided into the following sections: (1) astronomy, mathematics, physics; (2) bacteriology, botany; (3) zoology, physiology, medicine; (4) chemistry, agriculture; (5) geology, geography; (6) archeology. The following are the Urbana committees: Hotels, Professor S. A. Forbes, chairman; Local Arrangements, Professor G. D. Beal, chairman; Entertainment, Professor C. R. Richards, chairman; Publicity, W. H. Stoek, chairman; Papers, W. S. Bayley, chairman.

ON January 7 and 8, a number of professional geologists of the southwest met at Norman, Oklahoma, for a two days' conference. The conference was called for the purpose of presenting and discussing various topics of interest to those geologists engaged in the petroleum industry. The conference was attended by forty visiting geologists and fifty major students and members of the faculty of the department of geology of the University of Oklahoma. The meeting was presided over by Charles H. Taylor, head of the department of geology of the University of Oklahoma, who was responsible for calling the conference. A number of profitable papers were read. Dr. van Waterschoot van der Gracht, director of the Netherlands Geologic Service, presented a paper on the Salt Domes of Northern Europe. Mr. E. L. DeGolyer, chief geologist for the Pearson Syndicate, presented a paper on the geology of Northwest Texas. Mr. A. W. McCoy, instructor of geology at the University of Oklahoma, read a paper on Capillarity Underground. Other geologists who appeared on the program were Dr. J. A. Udden, director of Texas Geological Bureau; C. W. Shannon,

director of the Oklahoma Geological Survey; R. A. Conkling, chief geologist, Roxana Petroleum Company; L. E. Trout, chief geologist, Maryland Oil Company; C. N. Gould and Harper McKee, consulting geologists; and M. G. Mehl, W. C. Kite and Charles H. Taylor, of the department of geology, University of Oklahoma. Much interest was shown in the reading and discussion of these papers. No organization was formed, but Professor Charles H. Taylor and Director C. W. Shannon were elected a committee to arrange for another similar meeting to be held at Tulsa, Oklahoma, at some future date.

The London correspondent of the *Journal* of the American Medical Association writes that the British authorities have decided that students in the fourth and fifth years of study should complete their course as rapidly as possible but that students in the first, second and third year should join the army. The effect of recruiting is shown by the statistics of ten leading medical schools, in which, during the first year of the war, the number of students was 1,891, as compared with the normal number of 2,562. The number of medical students who have entered Cambridge University this year is forty-one, as compared with 116 in the year 1913. The director general of the Army Medical Corps has asked for an additional 2,000 physicians before Chrismas for war service. The casualty lists of one week show the names of fifteen physicians, and the obituary lists of physicians killed usually three or four. Sir D. Macalister, in his presidential address at the opening of the present session of the General Medical Council, said that within the next few months every qualified man of suitable age who was fit for the work of an officer in the medical corps would be needed. From the British dominions and from other countries over 240 physicians had been registered this year, and when certain reciprocity arrangements had been completed, the number from Canada would be considerably increased. Although the War Office authorities recognized that the withdrawal from professional instruction of large numbers of medical students, of the first years, would have a serious effect on the future, they had deemed it inadvisable to discourage junior students who offered themselves for combatant service. The result of medical students accepting commissions and enlisting was that the prospective shortage of 250 qualified practitioners per annum, which he had mentioned on a former occasion as probable during the coming years, would almost certainly be exceeded. There was one direction in which it appeared likely some economy of medical students might be effected. The minor vessels of the fleets carried a surgical "probationer," and for this work medical students who had completed their physiologic and anatomic studies and had been instructed in surgical dressing are preferred. He was authorized to make it known that any "probationer," who after, say, six months' service, desired to present himself for a professional examination or to resume his studies, would be granted leave of absence or be demobilized, and a less senior student be appointed in his place. By such rotation of service, a succession of students might continue to be employed in war work and yet the qualification of none would be unduly delayed.

Nature says: "The accounts of the local committee of the Manchester meeting of the British Association, held in September, lately issued, show that the resolution to observe the strictest economy in view of the exceptional circumstances in which the meeting was held was faithfully kept, and the local officers are to be heartily congratulated on the success of their efforts in this as in other directions. The expenditure amounted to only £862 15s., and 22 per cent. was all that it was necessary to ask from the guarantors. On the occasion of the previous meeting, in 1887, the expenses reached £3,652, and 35 per cent. of the much larger guarantee fund was called up. The meeting was in every way a success; it was attended by many eminent scientific men, the papers and discussions were of high value, and the arrangements gave such satisfaction that at the concluding meeting of the general committee many influential members expressed the hope that future meetings might be "run" on the same lines, excluding much of the lavish

and costly expenditure on entertainments and excursions.

UNIVERSITY AND EDUCATIONAL NEWS

ANNOUNCEMENT of a gift of $250,000 for a library for Amherst College was made at the annual banquet of the Amherst Alumni Association of New York. The library is to be a memorial to a graduate of the class of 1867 from a brother whose name is withheld.

A GIFT of $150,000 from a graduate of Wellesley College toward the fund for a new administration building is announced. The donor does not wish her name made known at this time.

PRELIMINARY plans for the chemistry building at Throop College of Technology, in Pasadena, have been completed, and the architects, Mr. Elmer Grey, of Los Angeles, and Mr. Bertram G. Goodhue, of New York City, are at work on the complete detailed plans and specifications of the building. The building is to cost $60,000 and construction will be begun probably within thirty days. The building is to be ready for occupancy next September, and Dr. Arthur A. Noyes will inaugurate his research work in the new laboratory about December, 1916. He has just returned to Boston after a few weeks' stay in Pasadena, which time was spent in working out plans for the building, and for the development of the department of chemistry, and the special research laboratories.

IT is announced that a group of prominent dentists of New York City some months ago submitted to Columbia University a detailed proposal to create a dental school. The proposal has the approval of the faculty of the college of physicians and surgeons. Candidates for admission would be required to possess the same academic training as students entering the study of medicine at Columbia, namely, the completion of two years of work in an undergraduate college.

DR. J. T. KINGSBURY, president of the University of Utah, has presented his resignation to take effect at the end of the present academic year. It will be remembered that the administration of the University of Utah, which led to the resignation of seventeen members of the faculty last spring, has been reviewed and criticized in a report of a committee of enquiry of the American Association of University Professors.

DR. KATE GORDON, head of the department of education, Bryn Mawr College, goes next September to the Carnegie Institute of Technology, Pittsburgh, where she will have charge of the Bureau of Mental Tests and give instruction in psychology in the woman's department of the School of Applied Design.

AT Yale University, Henry Laurens, Ph.D., has been promoted to an assistant professorship of biology in Yale College.

DR. V. E. EMMEL, of the Washington University Medical School, St. Louis, Mo., has been appointed assistant professor of anatomy in the University of Illinois college of medicine, Chicago, Ill.

DISCUSSION AND CORRESPONDENCE

INSECTS IN THEIR RELATION TO THE CHESTNUT BARK DISEASE

A RECENT bulletin[1] of the Department of Forestry of the commonwealth of Pennsylvania discusses the relation of insects to the bark disease. This paper bears the title, "Insects as Carriers of the Chestnut Blight Fungus," and as such tabulates a number of insects collected and found carrying spores of this parasite. Tests were made on some seventy-five insects representing about twenty-five species. Of these, fifty-two were collected while on chestnut blight cankers. From these experiments it was found that thirty per cent. of these insects carried numbers of the pycnospores of this fungus on their bodies and that the highest counts by far were obtained from the spore-feeding longicorn beetle *Leptostylus macula* Say.

The citation of these results as proof merely that insects are carriers of the chestnut blight spores is entirely justifiable, but in drawing

[1] Studhalter and Ruggles, Bull. 12, Dept. Forestry, Commonwealth of Pennsylvania, 1915.

their conclusions the authors make the statement (p. 28) that

> they (*i. e.*, some insects) are important agents in the local dissemination of this disease. This is especially true of the beetle, *Leptostylus macula*.

They also dispute the conclusion reached by the writer[2] that *Leptostylus macula* is a more important factor in destroying the spores of this disease, and state (p. 20) that

> the large number of spores carried by this beetle certainly indicate that it may be an important agent in the dissemination of the blight fungus.

In the writer's opinion these statements lack proof. From the fact that the insects have spores on their bodies the conclusion can not be drawn that they disseminate the disease. It is shown that the spores may be brushed off from the bodies of the insects even though with difficulty, but the question is, Where are they brushed off? If the life histories and activities of many of these insects had been more carefully observed an opposite conclusion to that reached by the authors would appear to have been a more natural one. To disseminate this disease it would be necessary for the insect to migrate from infested to healthy trees. With most of the Coleoptera discussed in this publication this is not the normal habit.

In the case of *Leptostylus macula* it can be positively stated that under normal conditions this insect never frequents healthy trees. It must be admitted that in crawling from one canker to another for the purpose of eating pustules, this insect possibly would spread the spores to start a new infection on the same tree, but this would be insignificant in contrast to the fact that the rain, as stated (p. 23), washes these spores down the tree in large numbers.

The extent to which this, as well as certain other species, feeds on these fruiting bodies is illustrated by trees, examined by the writer, on which from 50 to 75 per cent. of the cankerous area was eaten clean of pustules. From such habits it would be natural to expect a far greater percentage of spores on this species than on others.

[2] Science, N. S., XXXVI., p. 825, 1912.

Of the three other species of beetles listed by the authors as carrying spores, all are known to feed on dead wood and therefore are not likely to frequent living trees. Of the thirteen ants collected under natural conditions and tested for spores, only three were found to carry those of *Endothia parasitica*. Ants frequent living trees, especially those infested by aphides, and in case they carry spores conditions would be favorable for infection of the wounds made by the aphides. But it is shown that only a small number of ants in nature were found to carry spores. Most of the other insects discussed may be considered as occasional visitors, such as those which rest on the trees between flights; of these, few are recorded as carrying spores. The only other insects discussed that might possibly be responsible for direct transmission of the disease are tree-hoppers, which might infect the wounds they make while ovipositing.

In discussing the dissemination of other fungous and bacterial diseases by insects (pages 7–11) the authors cite cases in which a direct relation between host and insect can be established, as fire blight of pear, spread from blossom to blossom by pollen-bearing insects, and by aphides which puncture the living tissue; and ergot of rye, where the insects are attracted by a saccharin solution oozing from the conidia-bearing surface. In discussing the chestnut insects the authors establish no such relation; in fact, the most important insects, in the writer's estimation, in which some such relation might be proven are not mentioned in their experiments. The first of these insects in importance is the longhorned beetle *Leptura nitens*, which bores in the bark of 90 to 95 per cent. of the living trees over 10 inches in diameter throughout the chestnut range and in addition has adapted itself for breeding in great numbers in chestnut blight cankers. The interrelation thus established by the beetle between the living, healthy trees and the cankers on diseased and dead trees would provide favorable conditions for the transmission of the disease. The adaptation of this beetle to life in chestnut blight cankers has become so marked in old infected tracts that it

has often been difficult to find the larvæ in healthy trees, although they were present in greatly increased numbers in the cankers. Thus this insect, which is undoubtedly of importance as a carrier of spores to healthy trees, would, as the infections grew old, become less so owing to its increasing tendency to breed in and frequent diseased trees to the exclusion of healthy ones. Other insects which come in this category are several species of moths of the genus *Sesia,* although, in the case of these, observations indicate that adaptation to a life in cankerous tissue has not developed to so great an extent.

Of more importance in providing for the spread of the chestnut bark disease are the fresh wounds made by certain insects through the outer bark of the tree to the cambium whereby spores disseminated in various ways can gain entrance. Of first rank among insects which work in this way are *Leptura nitens,* which, as stated, is found in 90 to 95 per cent. of the trees over 10 inches in diameter throughout the chestnut range, and the chestnut bast-miner *Ectoedemia phleophaga* Busck, which is found abundantly in 95 per cent. of the saplings and younger trees throughout the natural range of the chestnut. Less abundant, though also widely distributed, are three species of *Sesia—S. castanea* Busck, *S. scitula* Harris, and *S. pictipes* G. & R. All these insects attack perfectly healthy trees and make wounds at various situations over the entire bark surface of trees from those of sapling size to those which are matured. Furthermore, most of them are abundant and widely distributed. These wounds are all holes made by the larvæ either for the extrusion of frass—in which case they are present and used throughout the entire larval life—or for exit when the larvæ are preparing to leave the open to the cambium and surrounded by the moist dead tissue necessary[3] for the growth of the spores. Thus practically all chestnut trees in their natural range have numerous open wounds whereby wind-blown and rain-washed spores can gain entrance. Young cankers have been found starting in wounds of both types mentioned.

Wound makers of another class are the cicadas, tree crickets, tree-hoppers and aphides. These puncture the bark in ovipositing or feeding. In numerous cases the blight has been found starting in cicada and tree-hopper wounds. A possibility exists that these insects both carry the spores and directly inoculate the wound; but such a chance is slight from the fact that insects of this kind normally frequent healthy trees.

In conclusion it may be said that in view of the facts established, namely, that ascospores are carried about by the wind in great numbers and that the pycnospores are washed down the trunks by the rain, the rôle played by insects in the transmission of this disease in merely transporting the spores is insignificant. On the other hand, owing to these same characteristics of the disease, the part played by insects in making wounds in the living cambium where such spores can gain entrance is far more important, and such wounds have been commonly found infected. Again, the fact that certain insects frequent diseased trees and eat the pustules, thereby preventing the dissemination of the spores, can certainly not be considered other than a benefit.

F. C. CRAIGHEAD
BUREAU OF ENTOMOLOGY,
U. S. DEPARTMENT OF AGRICULTURE

[3] Rankin, W. H., "Phytopathology," Vol. 4, p. 242, 1914.

CANCER AND HEREDITY

IN final reply to Dr. Little, of Harvard, there are three things to be said:

I

My results in cancer transmission are these:

1. The establishment of strains of mice which both in inbreeding and in hybridization transmit spontaneous cancer through as many generations as I please to carry it, and in a percentage which can be predicted with a surprising nicety. For example, certain strains of mice have been producing a fairly steady percentage of spontaneous cancer in this laboratory for five years without a break.

2. I have taken strains riddled with cancer and by the type of breeding tests described in my published work have eliminated the disease absolutely from the strain and its hybrids.

3. A mass of data still unpublished shows that these things can be done not only with cancer in general, but also with cancer of specific organs and of specific types.

The persistent criticism of my "unorthodox" results in *color transmission* in this hallowed cross between an albino and a house-mouse only serves to confuse the issue with regard to the question of cancer inheritance; and if Dr. Little wishes to criticize my cancer work further, in the interests of logic I ask him to do so on the lines of my cancer work and not on the basis of color transmission.

II

It is impossible to agree with Dr. Little that any reference to "the great laws of heredity" must necessarily refer only to Mendel's laws, since every student of genetics knows that there is a vast array of facts of heredity which by no possible compression can be forced within the limits of these laws. Especially does every worker with the coat colors of mice know this fact. Perhaps an amendment may in time be added to those theories now supposed by Dr. Little to be a closed issue like the Koran.

III

The publication of my results in color transmission will be attended to in due time. These data belong with a mass of facts collected in the study of the inheritability of coat pattern. It would be impossible to get this material in form for immediate publication without seriously neglecting experiments now under way in the study of cancer.

Maud Slye
The Otto S. A. Sprague Memorial Institute

A MOLLUSK INJURIOUS TO GARDEN VEGETABLES

During the past summer a small slug or *Limax* was noted to be injuring garden vegetables of several kinds. It seemed rather large for the common *Agriolimax agrestis* (Linné) and specimens were submitted to Dr. H. A. Pilsbry for an opinion. They were found to be this species. Both underground vegetables and the leaves of the plants were attacked. In Canandaigua they were observed to attack potatoes, the mollusk frequently eating a hole in the tuber as large as its own body. As many as a dozen potatoes were observed to be thus eaten. In the same garden this slug attacked the string beans, eating into the full pods and consuming the beans. In Rochester, a garden was examined in which the potatoes were affected in the same manner as those at Canandaigua. In Syracuse, this slug was observed in cauliflower, in company with the smaller black slug, *Agriolimax campestris* (Binney). Some lettuce was also eaten by these mollusks. It is probable that this slug (*agrestis*) may become a pest in some localities.

Agriolimax agrestis is very abundant about Syracuse, in the east end, the hill portion, where one may see dozens of the slugs crawling on the sidewalk after a rain in a manner similar to the earthworms. This is particularly true on Euclid Avenue, where the morainic hills border the sidewalk on the south side. This brown slug as well as its smaller black relative is abundant in the woods and fields in and around Syracuse.

Frank Collins Baker
New York State College of Forestry,
Syracuse University

SCIENTIFIC BOOKS

La Science Française. Librairie Larousse, Paris, 1915. 2 Vols. Pp. 396 and 403. Illustrated with portraits.

The dominance of German science during our generation seems to have been rather generally accepted, a principal cause of which is clearly seen in efficiency of organization essentially military in its nature. With attention now focused upon German efficiency, it is possible to discern certain elements of this success which before had been obscure. The systematic German mind, with its pertinacity and indefatigability of purpose, has found one of its expressions in the preparation of exhaus-

tive treatises for each branch of science, bigger and more comprehensive than any which had preceded them. Such treatises have been particularly full in their discussion of the work of German investigators, and the wide familiarity with the field of a science which results directly from successful compilation has yielded a type of authority quite distinct from, though often joined to, that which has been responsible for a great advance through original investigation. Those who have attended international congresses in some field of science have not failed to note that German delegates have been much the most strongly represented, whether the place of meeting were near or far from their native land, and that their papers presented at the meeting have been so coordinated as to produce a telling effect. In many cases provision has been made by the government for the expenses of professors who are in attendance upon such international meetings. It can hardly be doubted that German science has for these reasons been given a most favorable presentation before the representatives of other nations.

It is not impossible that the advantage of the German scientists due to their propaganda has been fully realized by the French nation; but in any case the new history of French science prepared by the Ministry of Public Instruction with special reference to the Exposition at San Francisco, has served well the purpose of revealing the high position of French science before the world, with the inevitable consequence of originality and initiative due to individualism as contrasted with organized group efforts. The two volumes serve to introduce the reader to a truly remarkable library covering the field of French science which was exhibited at the exposition. The collection was made up, on the one hand, of books yellow with age and, on the other, of those on which the ink is hardly dry. In the language of the general introduction by Lucien Poincaré:

"In these works of such varied date and such different aspects one finds concentrated, so to speak, the thought of an entire people; here is the essential part which France has brought to scientific progress; here is the display by the authors themselves of the great discoveries due to her creative genius.

"For each science the attempt has been made to trace the origin to the moment when in France an order of studies important by reason of the intellectual or moral profit which they have brought to the human race, was approached for the first time and became the object of researches systematically conducted. The desire has been to mark the origin, the point from which so many hardy explorers have gone out on the eternal voyage toward research and truth. There has been indicated along the path traced by their glorious efforts, the summits from which the new horizons have been descried. Finally, with some insistence there have been set forth those stations actually attained, to be surpassed by the labors of to-morrow through following directions which it was sought to make precise."

Each field of science has been treated by a master mind, and in no way can the high authority of the work be so well set forth as by a transcription of the tables of contents. The first volume, devoted to pure science, includes the following chapters: French Science at the San Francisco Exposition, by Lucien Poincaré; Philosophy, by Henri Bergson; Sociology, by Émile Durkheim; Educational Science, by Paul Lapie; Mathematics, by Paul Appell; Astronomy, by B. Baillaud; Physics, by Edmond Bouty; Chemistry, by André Job; Mineralogy, by Alfred Lacroix; Geology, by Emm. de Margerie; Paleobotany, by R. Zeiller; Paleontology, by Marcellin Boule; Biology, by Félix Le Dantec; Medical Science, by Henri Roger; Geographical Science, by Emm. de Martonne.

The second volume is devoted to the humanities, and includes the following chapters: Egyptology, by G. Maspero; Classical Archeology, by Max. Collignon; Historical Studies, by Ch.-V. Langlois; History of Art, by Émile Male; Linguistics, by A. Meillet; Hindu, by Sylvain Lévi; Chinese, by Ed. Chavannes; Greek, by Alfred Croiset; Latin Philology, by René Durand; Celtic Philology, by Georges Dottin; The French Language, by Alfred

Jeanroy; French Literature of the Middle Ages, by Alfred Jeanroy; Modern French Literature, by Gustave Lanson; Italian, by Henri Hauvette; Spanish, by Ernest Martinenche; English, by Émile Legouis; German, by Charles Andler; Juridical and Political Science, by F. Larnaude; Economics, by Charles Gide.

Each chapter is followed by a well-chosen bibliography of the great French works within its field, and the work is embellished by portrait illustrations, Pasteur having been selected for the frontispiece of Volume I., and Renan for Volume II. The press work, while without any luxurious quality, is dignified and in the best French taste.

Wm. H. Hobbs

University of Michigan

SCIENTIFIC JOURNALS AND ARTICLES

The December number (Vol. 22, No. 3) of *The Bulletin of the American Mathematical Society* contains: "Concerning absolutely continuous functions," by M. B. Porter; "On the representation of numbers in the form $x^3+y^3+z^3-3xyz$," by R. D. Carmichael; "On the linear continuum," by R. L. Moore; "A problem in the kinematics of a rigid body," by Peter Field; "Jules Henri Poincaré" (review of Enquête de "l'Enseignement Mathématique" sur la Méthode de Travail des Mathématiciens, second edition, and Lebon's Notice sur Henri Poincaré and Savants du Jour: Henri Poincaré, second edition), by R. C. Archibald; "Shorter Notices"; Breslich's First-Year Mathematics for Secondary Schools, by D. E. Smith; Braude's Coordonnées intrinsèques, by R. C. Archibald; Châtelet's Leçons sur la Théorie des Nombres, by E. B. Skinner; Salmon's Treatise on the Analytic Geometry of Three Dimensions, fifth edition, volume 2, by Virgil Snyder; Hermann Grassmann's gesammelte mathematische und physikalische Werke, Band 3, by E. B. Wilson; "Notes;" and "New Publications."

The January number (Vol. 22, No. 4) of the *Bulletin* contains: Report of the October meeting of the society, by F. N. Cole; Report of the twenty-seventh regular meeting of the San Francisco Section, by Thomas Buck; "Transformation theorems in the theory of the linear vector function," by V. C. Poor; Review of Hobson's John Napier and the Invention of Logarithms, 1614, and Gibson's Napier and the Invention of Logarithms, by R. C. Archibald; Review of Moritz's Memorabilia Mathematica, by R. C. Archibald; "Shorter Notices"; Hill's Development of Arabic Numerals in Europe, by D. E. Smith; Caunt's Introduction to the Infinitesimal Calculus, by T. E. Mason; Lenz's Die Rechenmaschinen und das Maschinenrechnen and Furtwängler and Ruhm's Mathematische Ausbildung der deutschen Landmesser, by E. W. Ponzer; Dickson's Algebraic Invariants, Borel's Leçons sur la Théorie des Fonctions, second edition, Bateman's Mathematical Analysis of Electrical and Optical Wave-Motion on the Basis of Maxwell's Equations, and Rutherford's Radioactive Substances and their Radiations, by R. D. Carmichael; "Notes"; and "New Publications."

SPECIAL ARTICLES

THE POISONOUS EFFECTS OF THE ROSE CHAFER UPON CHICKENS

Serious losses have occurred each year during June and early July, from chickens having eaten the rose chafers (*Macrodatylus subspinosus*). These losses have often been ascribed to various causes, but close observations have shown that the chickens are very fond of eating these insects in large numbers, and post-mortem examinations have revealed the presence of many undigested insects in their crops. The crops are usually so full as to give the impression that death had been due to a "crop bound" condition of the chickens. Some have also supposed that these deaths were due to a mechanical injury of the crop by the spines on the legs of the insects having punctured the lining of this part of the digestive system, while others have accounted for the death of these chickens by the rose chafers having bitten the crops.

A number of cases, some of which resulted

in the loss of several hundred chickens, were reported to the writer and experiments in feeding rose chafers to chickens were taken up at the Storrs Agricultural Experiment Station in 1909.

The deaths from this diet usually occurred in from nine to twenty-four hours after feeding. This led the writer to believe that undoubtedly death resulted from a cause other than a mechanical injury to the crop or "crop bound" condition. An extract was made from crushed rose chafers and distilled water, filtered, and fed to chickens in varying doses with a medicine dropper and this resulted in a great many deaths. Small chickens died in a few hours after feeding, older chickens of heavier weight when fed a small quantity of the extract lived but showed signs of poisoning; large doses resulted in their deaths. Mature hens did not die from the extract.

From 150 to 200 chickens have been fed either with the rose chafers or with varying strengths of the extract to determine the weight of the chicken killed by a certain amount of poison, also to determine the age limit of the chicke. s killed.

The results may be summarized as follows: 15 to 20 rose chafers are sufficient to cause the death of a chicken one week old. From 25 to 45 rose chafers are usually necessary to kill a three-weeks-old chicken. While some nine-weeks-old chickens have been killed by eating rose chafers, only one ten-weeks-old chicken was killed in these experiments. In the crop of this chicken there were 96 undigested rose chafers counted in post-mortem examinations.

The chickens feed upon the insects ravenously, being attracted by their sprawly appearance and usually within an hour after eating they assume a dozing attitude, later leg weakness shows and the chicken usually dies within twenty-four hours of having eaten these insects, or begins to improve after this time.

In less than five per cent. of the deaths convulsions occurred. Post-mortem examinations showed no abnormal condition of the organs. In order to exclude the possibility of arsenical poisoning due to the rose chafers having fed upon leaves that have been sprayed, tests were made by a chemist for arsenic, but no evidence of arsenic was found.

Intravenous injections were made in these experiments, extracts for injection being made from forty grams of rose chafers and sixty c.c. of a salt solution having a specific gravity of .9 per cent. This extract was put in a centrifuge for five minutes, the extract drawn off in a pipette and filtered in vacuo. Three c.c. of this extract were injected into a 690-gram rabbit intravenously and this died in six minutes. Another rabbit, weighing 1.435 grams, died in three and one quarter minutes after an injection of four c.c. A small 610-gram rabbit, when injected with two and one half c.c., died in fifty-five seconds after injection, and a large 1,450-gram rabbit died in two hours and thirty-five minutes after being injected with two c.c. Other rabbits were injected and killed by this extract, but further work needs to be done to determine what is a lethal dose for rabbits and experiments in feeding rabbits per os will be taken up next summer.

As nearly as the writer can determine, the rose chafers contain a neuro toxin that has an effect upon the heart action of both chickens and rabbits and is excessively dangerous as a food for chickens.

Owing to the fact that the insect feeds upon such a large number of plants, particularly on daisies, it seems essential that chickens be kept in mowed fields and away from yards having grape vines and any flowering shrubs during the month when the rose chafers are about, especially during years when rose chafers are particularly abundant.

GEORGE H. LAMSON, JR.
CONN. AGRICULTURAL COLLEGE,
STORRS, CONN.

THE AMERICAN SOCIETY OF ZOOLOGISTS

THE American Society of Zoologists held its thirteenth annual meeting jointly with Section F and in affiliation with the American Society of Naturalists, December 28, 29 and 30, 1915, in Townshend Hall, Ohio State University, Columbus, Ohio.

BUSINESS SESSION

New Members

At the session for the transaction of business, held on the afternoon of December 29, President Wm. A. Locy presiding, the persons who had been nominated for membership in the society and who were recommended for election by the executive committee, were duly elected. A list of the names of these newly elected members follows:

Leslie Brainerd Arey, Northwestern University Medical School, Chicago, Ill.

George William Bartlemez, University of Chicago, Chicago, Ill.

William John Crozier, Bermuda Biological Station, Agar's Island, Bermuda.

Rhoda Erdman, Yale University, New Haven, Conn.

J. F. Gudernatsch, Cornell University Medical School, New York City.

L. V. Heilbrunn, University of Chicago, Chicago, Ill.

Julian Huxley, Rice Institute, Houston, Texas.

Roscoe R. Hyde, State Normal School, Terre Haute, Ind.

Sidney I. Kornhauser, Northwestern University, Evanston, Ill.

George N. Papnicolaou, Cornell University Medical School, New York City.

Frank H. Pike, Columbia University, New York City.

William Albert Riley, Cornell University, Ithaca, N. Y.

Reynold Albrecht Spaeth, Yale University, New Haven, Conn.

Olive Swezy, University of California, Berkeley, Calif.

Morris Miller Wells, University of Chicago, Chicago, Ill.

J. E. Wodsedalek, University of Idaho, Moscow, Idaho.

Sewall Green Wright, Department of Agriculture, Washington, D. C.

Officers

The ticket agreed upon by the committee on nominations, appointed by President Locy and consisting of C. M. Child, George Lefevre and Raymond Pearl, was approved by the society and officers were elected as follows:

For president during the year 1916, D. H. Tennent.

For vice-president during the year 1916, Charles Zeleny.

For member of the executive committee to serve five years, R. P. Bigelow.

For member of the executive committee to take the place vacated by the president-elect, L. J. Cole.

Report of Secretary-Treasurer

Financial Statement:

Balance and Receipts

Balance on hand January 1, 1915	$689.15
Dues received from members during the year 1915	273.10
Interest on deposits in Title Guarantee and Trust Co.	30.56
Dividend on fund in Industrial Savings and Loan Co. from J. H. Gerould, trustee	15.00
Total	$1,007.81

Disbursements

2,028 stamped (2 c.) special envelopes ..	$43.32
605 stamps (2 c.)	12.10
Typewriting (circular letters, addresses, etc.)	19.15
Typewriter supplies	1.00
Express charges	5.69
750 Columbia clasp envelopes	6.75
350 copies printed list new members	19.33
700 copies blank due bills	3.00
350 copies proceedings 1914 meeting	13.98
350 copies announcements 1915 meeting.	7.10
1,000 nomination blanks	8.25
500 copies of program for 1915 meeting.	16.90
Expenses of Sec'y-Treas. at 1915 meeting.	41.56
Total disbursements	$198.13
Total amount received	1,007.81
Balance on hand Dec. 29, 1915	$809.68

Unpaid Dues

Number of members with dues in arrears:		
For the years 1913, 1914, 1915...	1....	($3.00)
For the years 1914 and 1915 ...	12....	($24.00)
For the year 1915	41....	($41.00)
Total	54....	($68.00)

Section Established

For the information of the Society it was reported that a permanent Pacific Section of the American Society of Zoologists was organized last summer which cooperated with the American Association for the Advancement of Science in holding a successful zoological meeting in connection with the Panama Exposition in San Francisco.

Conflict between Zoologists and Naturalists in Time of Holding Meetings for Reading Zoological Papers

The secretary also reported that the executive committee has been unsuccessful in its attempt to arrange with the executive committee of the American Society of Naturalists a plan whereby the two societies will not schedule simultaneous sessions for the reading of papers of interest to members of both societies, and, after some discussion, the following motion by H. S. Jennings was passed by this society.

The society recommends to the executive committee the desirability of consulting with officers of the American Society of Naturalists, Section F, and the Botanical Societies, as to the formation of a union section for the presentation of papers in genetics and evolution, this section, if need be, to hold meetings parallel with those of other sections of the societies.

Committee on Premedical Education

A report from the committee on premedical education having been called for, H. B. Ward, chairman of the committee, explained satisfactorily the delay in presenting a report.

The society, after some discussion, expressed its hope that there will be a continuation of the discussion of the subject of premedical education between the committees appointed for this purpose by the American Societies of Zoologists and Anatomists, which will result in substantial agreement and a specific report.

Committee on Memorials

The committee appointed at the last annual meeting to prepare suitable memorials of Seth Eugene Meek and Charles Sedgwick Minot, deceased members, submitted the following, which were adopted and ordered to be placed with the minutes of this meeting and published with the proceedings.

Seth Eugene Meek

April 1, 1859—July 6, 1914

Dr. Seth Eugene Meek was born in Hicksville, Ohio, April 1, 1859, of Scotch parentage. He studied at Valparaiso University and obtained the degree of S.B. in 1881. Continuing his studies at the University of Indiana he received the degree of S.B. in 1884 and M.A. in 1886. He was a Fellow at Cornell University from 1885 to 1886, and was granted the Ph.D. degree from the University of Indiana in 1891.

He married Ella E. Turner, December 25, 1886. He held the following positions: Professor of natural sciences, Eureka College, 1886–1887; Coe College, 1887–92; assistant professor of biology and geology and curator of the museum, University of Arkansas, 1892–96; curator of ichthyology, Field Columbian Museum, 1897 until the time of his death. He studied at the Naples Laboratory in 1896–97, and was in the employ of the United States Bureau of Fisheries in the summers from 1887 to 1897.

He carried out numerous explorations for ichthyological data, especially concerning the geographical distribution of fishes in Canada, the central and western United States, Mexico, Guatemala, Nicaragua, Costa Rica and Panama. He acted as ichthyologist for the Biological Survey of Panama in 1911–12.

His scientific publications comprise over seventy papers, dealing largely with the taxonomy and geographical distribution of American fishes. His best work is probably that on the fresh-water fishes of Mexico and Central America; especially his memoir published in 1904 on the fresh-water fish of Mexico north of the Isthmus of Tehuantepec; besides dealing with the taxonomy this memoir contains an important analysis of the geographical distribution of fishes and includes descriptions of many new species. His previous work in Central America, especially in Guatemala and Nicaragua, had given a basis of experience which enabled him to speak with authority, and would, no doubt, if his life had been spared, have led to valuable generalizations upon geographic and faunistic problems.

He was a careful and enthusiastic worker, a man of genial temperament and slow to anger, cautious and judicial in his attitude on doubtful questions.

The American Society of Zoologists puts this minute on record, and expresses its deep regret at the too early loss of such an honored member.

Charles Sedgwick Minot

1852–1914

In the death of Dr. Charles Sedgwick Minot the American Society of Zoologists has lost a valued and honored member and science an able and trusted worker.

The society, therefore, desires to place on its records the following minute in recognition of his services to science and to mankind.

Born to leadership, with an unusual talent for organization, Dr. Minot took a leading part in the foundation of a number of societies for the advancement of biological research. Amongst these

was the American Morphological Society, the forerunner of the American Society of Zoologists, and in the year 1896–97 he was its president. Later, when his interests lay rather in the field of anatomy and medical education, his scientific work retained the character of its earlier days and still commanded the interests of the wider circle of biologists. From the very beginning of his career, his mind showed a grasp of the larger problems of science, and while accurate and painstaking to an unusual degree, his incisiveness of thought and expression, and his broad outlook stood out as his predominant characteristics. Ever ready to help with sound advice or arduous labor any enterprise for the advancement of his chosen field, he was not one to shirk the disagreeable duties of life or to gloss over with fine words things that were not right. He voiced his opinion courageously and effectively when occasion called, but his criticism, though keen, was constructive and his active cooperation was always welcome and often indispensable—a true and helpful comrade, a wise and fearless leader.

Propositions from Wistar Institute

After a general discussion of the following offer made by the director of the Wistar Institute, Dr. Milton J. Greenman, to the members of the society in order to secure more permanent support and general distribution of zoological journals published by the Wistar Institute—"*that we* (the Wistar Institute) *offer to members of the American Society of Zoologists, all issues of the Journal of Experimental Zoology* (two volumes per year, present price $10.00) *or all issues of the Journal of Morphology* (about one and one third volumes per year, price $12.00) *for $4.50 in yearly dues per member to be paid by the society*"—the society instructed its executive committee to secure, if possible, an offer more nearly the equivalent of that made to the membership of the American Society of Anatomists, subject, however, to modification such as to permit those members who are also members of the American Society of Anatomists, to secure for $4.50 the issues of the journal they do not receive by virtue of dues to the American Society of Anatomists, all other members to pay $6.50, through the American Society of Zoologists and receive all issues of four journals.

In case such an offer is secured, the executive committee was given power to increase the annual dues to $5.00 or $7.00, as the case may be, and to enter immediately upon such an agreement.

Fahrenheit Thermometer Bill

The question of passing a resolution favoring favorable action by congress upon the bill for abolishing the use of the Fahrenheit thermometer in government publications was presented and being informed by H. B. Ward that the advisability of passing such a resolution is being debated by the Physicists, within whose field the subject more properly belongs, the society decided to take no action.

Concilium Bibliographicum

The urgent need of the Concilium Bibliographicum for funds at the present time, due to conditions in Europe caused by the war, to enable it to continue its work, was presented by E. L. Mark, and upon his motion the secretary-treasurer was instructed to forward to the Concilium Bibliographicum, Zurich, Switzerland, from funds in the treasury the sum of two hundred dollars.

Invitation to Meet in Minneapolis

A cordial invitation from men of the various scientific departments of the University of Minnesota to meet at some time in the near future in Minneapolis was transmitted to the society through H. F. Nachtrieb. The secretary was instructed to bring this invitation to the attention of the executive committee, and the hope was expressed that the next meeting in western territory may be held in Minneapolis.

List of Officers and New Members

The secretary was authorized to print and distribute lists of officers and new members and to make such corrections to the list of members as may be necessary.

Sessions for Reading Papers

Sessions for reading papers listed on the program were held on the forenoon and afternoon of Tuesday, December 28, and on the forenoon of Wednesday, December 29. Vernon L. Kellogg, vice-president of Section F, presided at the session held on the afternoon of Tuesday; Wm. A. Locy, president of the Zoologists, presiding at all other sessions.

A list of the papers read in full or by title, together with abstracts of each paper, classified according to general subjects, follows:

ECOLOGY

The Effect of Certain Ions on Rheotaxis in Asellus (illustrated with lantern): W. C. Allee, Lake Forest College.

Of the kations tested, potassium and rubidium

alone cause a strong increase in the positiveness of the rheotactic reaction of the isopod, *Asellus communis* Say. Sodium has a similar but less pronounced effect. The efficiency of the chlorine salts in causing this change is:

$$Cs < Li < Na < Rb < K,$$

or, arranging in order of their chemical activity:

$$Li < Na < K > Rb > Cs.$$

The anions also affect the rheotactic reaction. In a series of potassium salts KCl gives the greatest increase in positiveness. The favorableness of the anions tested is:

$$Br, I, No_3 < CH_3Coo, < ClO_3 < SCN < Cl,$$

with chlorine much more favorable than its nearest competitor. The relative toxicity of neither the anions nor kations runs parallel with their relative effect on rheotaxis.

Any ion in the concentrations (usually $N/.5 - N/10$) used in these experiments will cause a decrease in the positive rheotactic reaction if allowed to act for sufficient time. Calcium almost always causes this depression without a preliminary increase. Strontium and barium act similarly, but magnesium often stimulates before depressing.

By alternating an isopod between $N/10$ solutions of KCl and $CaCl_2$ its rheotactic reaction has been alternately increased and decreased as many as seven times in the six hours before the animal succumbed to the treatment.

Negative isopods treated with KCl until strongly positive have their resistance to $N/400$ NaCN decreased, which indicates that their rate of metabolic activity has increased. $CaCl_2$ has exactly the opposite effect. These results support earlier work on the relation of rheotaxis and metabolism in *Asellus*.

Glacier Oligochæta from Mt. Rainier (illustrated with lantern): PAUL S. WELCH, Kansas State Agricultural College.

Mesenchytræus solifugus (Emery, '98; Moore, '99; Eisen, '05) and *Mesenchytræus niveus* (Moore, '99), found on certain Alaskan glaciers, are apparently the only recorded Oligochæta which normally inhabit snow and ice. Six collections, January 7 to June 17, 1915, from the snowfields and glaciers of Mt. Rainier, Washington, contain an undescribed enchytræid (*Mesenchytræus gelicus* n. sp.) which occurs abundantly in that very unusual habitat. Among the remarkable structural characters of this worm, the extent and complexity of the reproductive organs are perhaps most noteworthy. A pair of very large spermathecæ extends from IV./V. to XI., almost completely filling the cœlom, and containing surprising quantities of spermatozoa. A pair of well-developed sperm sacs, extending from XI./XII. to XXXV. and containing large masses of developing spermatozoa, are surrounded by a large ovisac which extends from XII./XIII. to XXXV. and contains in addition large quantities of developing ova. The penial bulb is very complex in organization. The specimens are very dark in color, due to the large amount of pigment in the hypodermis. Certain internal organs, especially the spermathecæ, chloragog cells and lymphocytes also contain pigment granules. The collections also contain specimens of *M. solifugus* Emery, a form which occurs in abundance on the permanent snow and ice fields of Mt. Rainier. Evidence points to certain snow algæ as one of the chief sources of food for both of these worms.

The Reaction of Fishes to Stimuli not Encountered in their Normal Environments: V. E. SHELFORD, Illinois State Laboratory of Natural History.

Wastes from the manufacture of illuminating gas are commonly thrown into streams and are probably more generally fatal to fishes than any other industrial wastes. In course of the investigation of the effects of products of the destructive distillation of coal upon fishes about twenty-five compounds have been studied. Nearly all are rapidly fatal when present in minute quantities. The reactions of fishes to these ingredients have been tested and the fishes tested are positive to fifteen of the twenty-five compounds, indefinite or indifferent to seven and negative to only two or three. Thus the reactions of the fishes are of such a nature as to destroy rather than to preserve them.

COMPARATIVE AND GENERAL PHYSIOLOGY

The Relation Between Wave-length and Stimulation in the Lower Organisms: S. O. MAST, Johns Hopkins University.

The relative stimulating effect of different regions of a spectrum having a known distribution of energy was ascertained for the following fifteen species: *Chlamydomonas, Trachelomonas* and *Phacus*, each one species; *Pandorina, Eudorina, Gonium* and *Spondylomorum*, each one species; earthworms, *Arenicola* (larvæ) and blowfly (larvæ) each one species.

The results obtained are briefly stated below

without corrections for the difference in the energy of these regions. They are, however, of such a nature that the corrections mentioned will not result in marked alterations.

For all but one of the microscopic organisms the results fall into two groups. In the one group the region of stimulation begins in the blue near the violet, between 430 $\mu\mu$ and 440 $\mu\mu$. From here toward the red end of the spectrum the stimulating efficiency rises, at first slowly and then rapidly, to a maximum in the green near the yellow, between 530 $\mu\mu$ and 540 $\mu\mu$; then it falls, at first rapidly and later more and more slowly, ending in the red at about 640 $\mu\mu$. In the other group the region of stimulation begins in the violet between 420 $\mu\mu$ and 430 $\mu\mu$, only a short distance from the place where it begins in the first group. From here the efficiency rises very rapidly, reaching a maximum in the blue between 480 $\mu\mu$ and 490 $\mu\mu$. It then falls rapidly and ends in the green in the neighborhood of 520 $\mu\mu$. Three of the microscopic forms, *Pandorina*, *Eudorina* and *Spondylomorum*, belong to the first group, the rest to the second. To this group belong also *Arenicola* larvæ and the earthworms. For the remaining microscopic form (*Chlamydomonas*) the maximum is in the green very near 510 $\mu\mu$; and for the blowfly larvæ it is approximately at 520 $\mu\mu$. The distribution in the spectrum, of stimulating efficiency is, for this creature, essentially the same as the distribution of brightness for color-blind persons.

These results show that stimulation in all of the organisms studied depends upon the wave-length of the light; that the stimulating efficiency is very much higher in certain regions of the spectrum than in others; but that the distribution of this in the spectrum differs greatly in certain organisms that are closely related in structure, *e. g.*, *Pandorina* and *Gonium*, while it is essentially the same in others that are very different in structure, *e. g.*, *Euglena* and earthworms. They also have a bearing on the nature of the chemical changes associated with the reactions to light.

Negative Orientation in Vanessa Antiopa: Wm. L. Dalley, Jr., Randolph-Macon College. (Introduced by S. O. Mast.)

Certain photo-positive insects orient, on coming to rest in direct sunlight, so that they face directly away from the sun. Is this phenomenon dependent upon previous violent exercises, as Professor Parker holds, and is it a reaction to light or to heat?

Vanessa, which has been raised in a small cage and had never flown in the open, repeatedly oriented negatively in sunlight, as did also specimens with both eyes covered so that no light could enter. Moreover, normal animals exposed in darkness to heat-rays from an electric flatiron usually face away from the source of heat, and they respond in the same way even when the heat-rays are opposed by light-rays coming from the opposite direction. Furthermore, when normal animals are placed in a room the temperature of which is high (29° C. to 32° C.) they do not orient at all, no matter how they are illuminated.

These results seem to show that when *Vanessa* faces away from the sun on coming to rest in sunlight, it is reacting to heat and not to light, and that this reaction is not necessarily dependent upon previous violent exercise.

Electric Currents Generated in the Eye of the Fish by Light: Edward C. Day, Syracuse University.

The live fish, wrapped in a wet cloth, gills irrigated by a hose led into the mouth, was placed in a dark box. Electrodes were applied to the eye, one to the cornea and one to back of eye-ball, and connected with string galvanometer. When light struck the eye the galvanometer recorded electrical disturbances. By projecting the shadow of the string into a photographic apparatus its deflections could be recorded along with time and exposure curves. On-effect consists of a slight depression *A*, followed by a strong abrupt elevation *B* and another slower secondary rise *C*. Off-effect consists of an abrupt elevation *D*.

For dark-adapted eye all four deflections are present; *B* is always greater than *D*. For light-adapted eye *A* and *C* are absent; *B* is smaller than *D*. Latent period from onset of light to beginning of $A = 0.032''$, $B = 0.075''$, $C = 1\text{–}7''$; and from extinction of light to beginning of $D = 0.05''$.

Deflections may be resultant expression of interfering reactions of three substances in the retina.

Intermittent stimulation gives oscillatory curve composed chiefly of *A* and *D* deflections; 25 flashes per second evoked 25 oscillations, and oscillations blended at 28 flashes per second.

Changes in Thelia bimaculata (Fabricius) Induced by Insect Parasites (illustrated with lantern): S. I. Kornhauser, Northwestern University. (Introduced by Wm. A. Locy.)

In *Thelia* pronotum covers entire body, extending far in front of head as a horn and back over thorax and abdomen. It is coarsely punctured

over entire surface, being in the male dark brown with large lateral spot (vitta) of bright yellow on each side, and in the female gray with only faint indication of vitta.

In parasitized males, color of pronotum corresponds to that of normal female. Not only is yellow lost from vitta, but characteristic pigment of female develops. Vitta of normal male is yellow because chitin is transparent (shows no melanin even in punctures), allowing a yellow hypodermal pigment (non-melanic and easily destroyed by acids and other organic solvents) to shine through. Punctures have no yellow pigment below them. In female vitta is gray because punctures are brown (due to melanin in superficial layers of chitin), and hypodermal areas are partially filled with grayish residue in cells and greenish pigment unevenly scattered. These female characters are assumed by fully parasitized males and the degree of change depends upon how long before its final moult the nymph was parasitized. Thus all intermediate stages of disappearance of yellow pigment and assumption of melanin have been found.

Normal female of thelia is larger than normal male; and abdomen and wings, less melanic. Measurements of pronota, wings and abdomens, show that parasitized males are larger than normal males, but not as large as normal females. There is also a reduction of melanin in abdomen and wings of parasitized males. Abdomen assumes pointed form of female, and posterior chitinous rings increase in length.

Internally, testes undergo fatty degeneration, and are finally entirely lost (either before or after final moult), although cell divisions (often abnormal) continue up to last vestige. Entire abdomen of male becomes crowded with fat, in which parasites are imbedded. Normally only female abdomen contains much fat, while that of male is almost entirely filled with testes, vas deferens and seminal vesicles. Assumption of female secondary characteristics by male must be due not only to loss of primary sexual organs, but also to changed metabolism (laying on of fat) caused by action of parasites themselves.

Differentiation and Dedifferentiation in Bursaria and its Significance: E. J. LUND, University of Minnesota.

During the process of regeneration of pieces of *Bursaria* a simplification of structure of the cut piece always takes place previous to differentiation. A similar process is evident during encystment and excystment, during normal division and sometimes periodically during the life of a normal individual.

The only conceivable ways, looked at from the standpoint of physical science, that "regulation," "regeneration," "making over," etc., of a complex structure can take place is: (1) (*a*) that it is first *simplified* physico-chemically to a greater or less extent; (*b*) that the products resulting from simplification are necessary and sufficient for the production of a different structure; (*c*) that these parts (resultant products, perhaps amino acids or simpler proteins, etc.) be capable of *recombination* in a *different* way, or (2) that a stereoisomeric change takes place in the system. But the latter is obviously insufficient to account for the changes actually taking place in regulating structures, and is not what would be expected from a knowledge of many chemical facts of metabolism. This statement of regeneration processes does not imply that antecedent properties which determine the specific path of differentiation (determiners of heredity) of the morphologically non-differentiated cell do not exist, nor that they are variable or invariable if they do exist.

Light Reactions of Diemyctylus: A. M. REESE, West Virginia University.

Diemyctylus is negatively phototropic to a marked degree at ordinary temperatures. At a temperature near 0° C. and at a temperature of about 36° C., it is more or less indifferent to light. The response is the same when the light comes from below.

It is positively phototactic to lights of all intensities, though this seems to vary with the different seasons. Experiments are now under way to determine this. At low temperatures the phototaxis may be inhibited or reversed.

It responds to red, green and blue lights as to white light, the response being less marked to green than to red, and still less to the blue.

Diemyctylus responds promptly to a spot of sunlight thrown upon various parts of the body by a small mirror, as has been noted by the author for *Necturus* and *Cryptobranchus*.

On Loss of Cell Pigment as an Index of Permeability Changes: W. J. CROZIER, Bermuda Biological Station.

Experiments with tissues of the nudibranch *Chromodoris zebra* give evidence showing that, at least in this case, which has the advantage of being uncomplicated by strong muscular contraction, the outward diffusion of cell pigment can not be used to estimate permeability increase quantitatively. The speed with which the pigment appears

outside the cell varies with the degree to which the tissue is stretched. In studying a large number of acids, no parallelism could be discovered between their rates of entrance into the cell and the order of pigment loss in the different acid solutions. Using the penetration time of acids as a criterion of penetrability (their entrance being shown by the color change of the pigment, which is a "good" indicator for acids), instances have been found in which the speed of acid penetration is accelerated, while loss of pigment is delayed, and, reciprocally, permeability toward acids may be caused to decrease while the pigment diffuses out of the cell.

The Doubtful Validity of the Hypothesis of Warning and Immunity Color: W. H. Longley, Goucher College.

This paper reports observations upon the color and color-changes of tropical reef-fishes of the West Indian region. The facts noted lead to the conclusions that the color of the fishes is very definitely correlated with their habits and that color-changes are adaptive. Of these ideas both seem incompatible with the conspicuousness hypotheses, but neither is at variance with the conception of concealing coloration.

Rate of Regeneration from New Tissues Compared with that from Old Tissues: Charles Zeleny, University of Illinois.

When a second removal of the tail of the frog tadpole is made at a level proximal to that of the first removal the tissue at the cut surface is the original old tissue. When the second removal is made distal to the first the cells at the cut surface are the newly regenerated ones. The levels of these cuts can be so regulated as to make possible a direct comparison of the rates of regeneration in the two cases. Such a comparison shows that there is no essential difference between the two rates, a slight advantage in favor of the regeneration from new tissues being probably not significant. In one of the experiments the specific amount of regeneration at the end of six days was .196 from old tissue and .204 from new tissue. At the end of eight days the corresponding figures were .303 and .310.

The result indicates that the primary factors controlling rate of regeneration are not those inherent in the condition of the cells which proliferate to form the regenerated tail. They are rather to be sought in the influence exerted by other parts of the organism.

The Function of the Efferent Fibers in the Optic Nerve of Fishes: Leslie B. Arey, Northwestern University Medical School. (Introduced by G. H. Parker.)

When the optic nerve only of *Ameiurus* is severed, the rods, cones and retinal pigment fail to execute their characteristic photomechanical responses. After hemisection of the nerve, movements of the elements occur only in that region of the retina adjacent to its intact side. It can not only be shown (since essentially normal responses occur in excised eyes and in eyes attached to the body by the optic nerve only) that a second mechanism exists in association with the muscles innervated by the oculomotor nerve, which inhibits these movements when the optic nerve is cut, but also that electrical stimulation of the peripheral stump of the optic nerve can overcome this inhibition.

Hence demonstrably functional efferent fibers exist in the optic nerve. Only by the balanced action of these components with a second extrinsic set of fibers (ciliary nerves?), which independently exert an inhibitory influence upon the movements of the retinal elements, are normal photomechanical responses accomplished. It is probable that efferent impulses in the optic nerve do not directly stimulate the retinal elements to motion, but rather act indirectly by blocking the tonic inhibition exerted by the second system. These efferent optic nerve fibers may be designated as visceral efferent nerve components.

Severance of the optic nerve of *Abramis* or *Fundulus* does not prohibit movements of the retinal elements, hence it is impossible to state whether the mechanism discovered in *Ameiurus* is or is not peculiar to that species alone.

The Relation of the Body Temperature of Certain Cold-blooded Animals to That of Their Environment: Charles G. Rogers and Elsie M. Lewis, Oberlin College.

A review of the literature upon the subject of the body temperatures of the so-called cold-blooded animals reveals a lack of uniformity of observations in part, at least, due to faulty methods of determination.

A knowledge of the temperature relations existing between cold-blooded animals and their environments is of importance in all experiments having to do with the determination of temperature coefficients of the rates of reaction of physiological processes. If the relation can be shown to be a constant one it is necessary only to control carefully the temperature of the environment in order to have knowledge of the actual temperature of the animal or tissue under observation.

Tests made upon earthworms, clams, two genera of salamanders and upon the gold fish by means of carefully guarded thermoelectric measurements indicate that in general these animals adjust themselves to the temperature of their environment with remarkable exactitude, within a very short time, the difference being usually measurable only in thousandths or hundredths of a degree Celsius.

Observations on Regeneration and Division in Ciliates: GARY N. CALKINS, Columbia University.

A definite division zone, not affected by loss of parts through cutting, has been demonstrated in *Paramecium* and *Uronychia*. In *Paramecium* regeneration of enucleated fragments never occurs, while regeneration of nucleated fragments varies with the race used. In *Uronychia* regeneration of nucleated fragments always occurs, and regeneration of enucleated fragments varies with age of the cell when cut. If cut within eight hours after division the latter never regenerates; if cut within two hours prior to division it invariably regenerates into a perfect, but enucleate, cell.

Precocious formation of powerful cirri, before division, is characteristic of *Uronychia*. This, and regeneration, are phenomena of the same type, both functions of the fully differentiated protoplasm. The experiments indicate differences in protoplasmic make-up in young and old cells; and the increasing power of regeneration with age in enucleated fragments indicates an increasing differentiation. When fully differentiated, enzymes are formed leading to precocious organ formation.

Cell division occurs when differentiation has gone a step beyond that necessary for regeneration. Enzymes are then produced which bring about cytolysis of the specialized protoplasm in the division zone. Through tension of the cell the membrane turns in and the cell divides by constriction.

With chemical activities at division the protoplasm is restored to the labile undifferentiated condition of young cells. If this restoration is incomplete a progressive differentiation of the racial protoplasm occurs, leading to depression and death, which are prevented by drastic reorganization phenomena of asexual, and sexual, endomixis.

The Distribution of Water in the Embryonic Nervous System: O. C. GLASER, University of Michigan.

Embryonic nervous systems of *Rana pipiens* contain more water anteriorly than posteriorly. Donaldson has found in the adult a difference in the same sense. The determinations in the embryonic material were necessarily made with systems incompletely isolated from other tissues.

An indirect method, free from this objection, gives the same result. Nuclear volume varies with the water content of the cell. In the nervous system only relative nuclear volumes can be dealt with, but the evidence from thousands of nuclei shows that the anterior ones are larger than the posterior, not only during folding, but also in the flat neural plate.

In the theory of autonomous folding which I have tried to develop, absorption of water is a symptom of surface changes in the neural cells, and these changes are held responsible for the folding. If correct, and if nuclear size is an index of water content, then nuclei in the curling edges of the neural plate should be larger than those in the flat portions of the plate at the same level. This, as the detailed evidence to be presented shows, is true.

From the beginning, then, the anterior end of the vertebrate nervous system has a higher water content than the posterior, and the absorption of water accompanies folding.

The Comparative Resistance of Marine Animals from Different Depths to Adverse Conditions: V. E. SHELFORD, University of Illinois.

Benthic animals from different depths differ strikingly in their resistance to adverse conditions. Individuals of the same species taken from different depths show the same relations as do species living at the same or correspondingly different depths. In general animals from two fathoms are two to three times as resistant to fresh water and high temperature as animals from seventy-five fathoms. Animals from deeper water are usually more resistant to excesses of acid and alkali than those from shallower. The differences in physiological character within single species show the unreliability of conclusions regarding distribution based on the assumption that physiological characters are uniform for entire populations.

The Change of the Blowfly Larva's Photosensitivity with Age (illustrated with charts): BRADLEY M. PATTEN, Western Reserve Medical School.

Larvæ of the blowfly were tested each day from hatching until pupation to determine what, if any, changes take place in the degree of their photosensitivity. The test employed consisted in subjecting maggots crawling under the influence of a horizontal beam of light to an instantaneous change of 90° in the direction of beam. The resulting change in the direction of the animal's

locomotion was measured in degrees by means of a protractor. The more sensitive the individual was, the more closely did its deflection approach 90°. Using the same larvæ throughout the experiments, one hundred trails were run each day. The *average deflection* of each of these sets of 100 trails was used to locate a point on an "age-sensitiveness" curve.

The curve of photosensitivity thus obtained shows a rapid rise during the first days of larval life, reaching a maximum on the fourth day with a deflection of 81°, and gradually dropping off till the time of pupation, when the average deflection was 58°.

The Physiology of Chemoreceptors: W. J. Crozier, Bermuda Biological Station.

A comparison of quantitative measurements of cell penetrability for acids with the relative stimulating powers of these acids and with the limiting dilutions beyond which they are ineffective in stimulating earthworms and four species of marine animals indicates: (1) that an acid stimulates by union with a constituent of the ceptor surface, and (2) that this surface is not simple but complex and contains probably proteins and fatty substances.

Encystment of Didinium nasutum: Gary N. Calkins, Columbia University.

Encystment of *Didinium* under culture, with adequate food and normal conditions, is preceded by a declining division rate in the race as a whole. Encystment lasts for about six days, when the organisms emerge with renewed vitality, as shown by an average division rate from five to ten times greater than that prior to encystment.

During encystment the cell undergoes complete reorganization. The macronucleus degenerates into fragments which are ultimately absorbed in the protoplasm. The micronuclei swell and divide by mitosis, the products giving rise to new macro- and micro-nuclei.

This reorganization occurred twice during the history of my *Didinium* culture with an interval of six weeks. After the second period the race did not encyst again, but continued to live with a slowly decreasing division rate for about six months, when the last individuals died with characteristic symptoms of depression.

The individual *Didinium* isolated was evidently well advanced in its racial cycle. This is indicated not only by loss of powers of encystment and reorganization, but also by the fact that *after* the two periods of encystment, and for ten days only in each case, epidemics of conjugation occurred in the stock material derived from organisms which had recently encysted. Asexual reorganization, apparently, merely restored the protoplasm to a condition in which conjugation was possible; a condition which is, in itself, evidence of advanced differentiation, and a condition from which the protoplasm is restored through conjugation.

On Cell Penetration by Acids: The Effects of Anesthetics and of Stimulation by Induction Shocks: W. J. Crozier, Bermuda Biological Station.

1. Anesthetics produce a reversible decrease in the permeability of *Chromodoris* tissues toward a range of dilutions of strong acids. The magnitude of the effect depends upon the concentration of the individual anesthetic and the time of its action, and may prolong penetration time by 100–200 per cent. Following the decreased permeability there ensues an increased permeability, irreversible in its later stages, which can be antagonized (delayed) by balanced salt solutions. Cytolytic agents increase permeability toward acids.

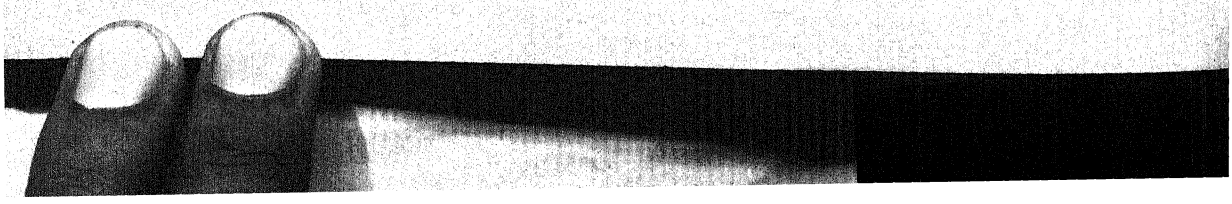
2. Stimulation by induction shocks decreases the penetration time of acids. The decrease in permeability toward acids produced by anesthetics may be inhibited by simultaneous strong stimulation.

Behavior of Holothuria captiva Toward Balanced Illumination: W. J. Crozier, Bermuda Biological Station.

The whole surface of *Holothuria* is reactive to light. These animals are negatively phototropic. In *H. captiva* the two sides of the animal are sensibly parallel, and when subjected to bilateral illumination there is accordingly no possibility of equalizing the amount of light on the two sides by assuming a position perpendicular to the axis of the opposed beams, or, in case these beams are of unequal strength, by pursuing a path at some definite angle with this perpendicular. This is in accord with the behavior of *Holothuria* and proves that photic stimulation in this animal depends upon the amount of light falling upon the sensitive surface, and is independent of the *angle* of incidence. The fact that isolated portions of the skin react to continuous light is further and conclusive evidence that the direct action of light, not change of intensity, furnishes the stimulating agency.

Caswell Grave,
Secretary-Treasurer

(*To be continued*)



SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PONCELET POLYGONS[1]

THERE is nothing which can not be known. Such at least is the postulate of science. Wide as is the universe of matter, numberless as are the objects and the events in the world of either dead matter or living organisms, yet the scientist must have faith that all can be observed, classified, named; that a finite number of terms and a finite system of laws will suffice ultimately for the summing up of what we call the external universe. A dream, if one regards it as a positive expectation! Yet how far it has gone in the direction of realization in certain obvious horizons! In our solar system it is not frequently that a major planet is discovered. In the chemist's domain, does any one concede that the unknown elements are more in number than the known? Does any physicist really expect to come upon a new kind of activity at all comparable in importance with the Röntgen rays? Though the ideal of complete knowledge and perfect explanation may be destined never to be reached, yet how prone are we to imagine that it must be not far away!

In a certain contrast to the material world stands the world of intellect and reason, a contrast partly at least fictitious, but also in part intrinsic. It is in this world that geometry exists. Whatever else be true about geometry, it is plain from experience and from history that its objects are ideas or notions; that they are comple-

[1] Address of the retiring vice-president and chairman of Section A of the American Association for the Advancement of Science, Columbus, December 30, 1915.

mentary to, not extracted from, the material world. Knowable they are, therefore, by their very constitution. But who can ever conceive of them as limited in number? Who can imagine that ever in the future it could come to pass that there should be no more geometric concepts to be investigated; that a point might be attained where the mind of the mathematician should rest satisfied, all its curiosity appeased?

Connected with this contrast in the source of its objects is the slowness with which new objects in geometry emerge and diffuse into general knowledge. Called into being by shifting stimuli, multitudes of new systems of relations are invented and named and investigated; but most of them are speedily forgotten (or perhaps only dimly apprehended even by the discoverer), and very few in a century are those which survive to become the valued heritage of later generations.

There are many occasions when we meet to discuss only what is new. The present, however, is a fitting occasion for reviewing together some of the treasures handed on to us by geometricians of the past, and for stimulating our own ardor by the rehearsal of the fortunes and successes of earlier workers in our part of the field of science. The polygons of Poncelet were new a hundred years ago, and are not yet forgotten, but seem rather to attract increasingly the interest and attention of geometricians. I invite you to enjoy with me, since though not unknown they are not yet in the class of familiar objects, a rapid survey of their character and development.

For many centuries before Euler students of geometry had found interest in circles inscribed in a triangle and circumscribed to it. Usually their centers do not coincide. One circle may be kept stationary, while the triangle varies, and with it vary also the center of the other circle and its radius. Euler may have been the first to write out the relation that connects these three quantities, the two radii and the distance of the centers: $R^2 = 2Rr + d^2$, or it may have been discussed a hundred times before. Publication of this relation led to the study of analogous relations for polygons of more sides, Fuss in St. Petersburg, and some years later Steiner in Berlin, carrying the problem farthest, finding results for polygons of 4, 5, 6, 7 and of 8 sides. The case of regular polygons, for which the inscribed and circumscribed circles are concentric ($d = 0$) is elementary, and will always stimulate interest in the more general problem.

While attention was directed to finding an algebraic relation corresponding to a given geometric diagram, for a long time no one seems to have inquired whether this relation was merely a necessary condition, or whether it might also be a sufficient condition for the construction of the diagram. If two circles are drawn, satisfying the condition for a triangle: $R^2 = 2Rr + d^2$, can one always determine the triangle inscribed in the circle radius R and having its sides all tangent to the circle of radius r? And is there only one such triangle in each case, or some finite number greater than one? What of the case where the triangle (or polygon of 4, 5 or more sides) is regular—is it exceptional that for that case there are an infinite number of polygons which satisfy the requirements, provided there is one such?

It is not easy to apprehend the state of geometric knowledge in 1796, when Fuss wrote on this subject. He certainly supposed that a triangle could occur singly, and was unaware that others can always be inscribed and circumscribed to the same pair of circles. It would seem as though the roughest kind of experimentation would have shown the truth, or at least would

have given grounds for a hypothesis. But Fuss limited his investigation, so Jacobi states, to the case where the polygon is symmetrical with respect to the common diameter of the two circles. Symmetrical-irregular polygons, he calls them; and this Fuss supposed to be essentially a restriction upon the generality of the problem, and hence he believed that he had solved only under limitations the problem proposed. This misapprehension apparently persisted for 26 years, until the appearance in 1822 of Poncelet's memorable work: "Traité des Propriétés Projectives des Figures." Indeed there is indirect evidence to this effect in an essay by Poncelet himself, of the date 1817, in which he challenges his correspondent to solve the problem of inscribing in a given conic a polygon of n sides, the sides to be tangent to a second given conic. This problem as stated is, as we now know, misleading, implying that there is a solution, and that the number of solutions is finite. Poncelet would hardly have ventured to publish such a problem had he not been sure that the mathematical public of that day would accept it in good faith.

It would be quite certain also, even if we had no direct knowledge of the fact otherwise, that the relations of collinearity and correlativity or reciprocity with respect to a conic were not at all commonly understood prior to 1822. The employment of transformations to derive one solution of a problem from another was not yet a recognized preliminary to all discussion. The student of conics to-day will reflect at once that two conics not specialized in situation have one self-polar triangle in common, and are transformed into themselves by three collineations or projectivities besides the identity, and are transformed simultaneously into each other by four reciprocities or polarities with respect to a third fixed conic. Thus to-day we should see in advance that any one triangle, or one pentagon, inscribed in one conic and circumscribed to another, implies seven others of the same sort. Solutions of Poncelet's problem must occur at least in sets of eight; but this fact, apparent from Poncelet's own discoveries, appears to have escaped his attention, and still less was it present to the minds of his contemporaries.

Knowledge of the investigations of Fuss and of Euler would have been almost useless to Poncelet. For the far superior generality of his problem, that of two conics in place of two circles, his method of projection is responsible. This allowed him to use metric properties of circles and draw conclusions concerning any two curves of the second order. But the discovery of his famous theorem on polygons was nothing less than a stroke of genius. Many have been quoted as authors of the saying that invention or discovery is the principal thing in geometry, while the proof is a relatively easy matter. In this case, however, the proof also is ingenious, carried on by the exclusively synthetic method. But the perception of the theorem, preceding its proof, escapes explanation from anything that had gone before. Were that his only contribution to our knowledge of geometry, it would ensure him grateful recognition from later students—as the compeer of Apollonius who gave us the foci of a conic, Desargues who first perceived poles and polars, Newton who described the organic construction of conics, and the immortal Pascal with his hexagon. Let us rehearse the theorem which gives a generic name to Poncelet polygons.

Of two given conics, call one the first and consider its points; call the other the second and consider its tangents. Form a broken line by taking a point of the first curve, a line of the second that passes

through it, then another point of the first on this line, and so forth. It may be that this process will close, the last line passing through the first point. If it does close, forming a polygon of n sides with vertices on the first conic and sides tangent to the second, then every point of the first is a vertex of one such closed polygon, and every tangent of the second is a side of one such polygon of n sides.

That is the first part of the theorem. The second is this. Diagonals of all these closed polygons, which omit the same number of consecutive vertices of the polygon, are tangent to a fixed third conic; and the dual statement is true concerning points of intersection of non-consecutive sides. *This latter part of the theorem is true even if the polygon is not closed.* From some points of view this scholium exceeds in importance the principal theorem.

These statements give us a specific attitude toward the conics. We look upon the first as a groove prepared to guide a set of sliding points, and the second as a directrix for lines joining the points. If the lines are indefinitely extended, there will be outlying systems of crossings; a first extra set whose motion will describe a first extra conic; a second extra set with its conic locus, and so forth. The case where the polygon is closed is that in which one of these extra loci coincides with the first conic.

We may digress to notice a curious fact. The sides of an inscribed hexagon meet in 15 points, namely, six on the conic, three on the Pascal line and six which we may term for the moment extra points. These six extra points are vertices of a hexagon *circumscribed* to a second conic. If now the first hexagon, already inscribed to one conic, becomes circumscriptible, then the hexagon of the extra points, already circumscribed to a conic, becomes inscriptible to another. This separation of two properties which occur together in all polygons of the Poncelet type is a situation deserving further attention.

To return to Poncelet: His discovery of the mobility, or the infinite multitude, of these polygons upon two fixed conics, published in 1822, must have seemed to mathematicians of that day as startling as the announcement of a new genus of vertebrates by a traveler returning from distant lands. Its exact character had to be ascertained and settled. The possibilities of variation must be examined; as, for example, whether all the sides of the polygon need be required to touch the same conic. Here it was seen by Poncelet himself that if all conics concerned pass through the same four basis points, then it is sufficient for the purpose if each side in its order touches its own assigned conic—all the vertices will still be movable on their common track. After this, it seems like a new proposition to assert that the order in which the fixed conics are touched by successive sides may be varied, and still the polygon will close in the same number of sides. And it is a new proposition, as announced within the last few years by Rohn, provided not merely their order, but also their *cyclic* order, is altered. Whether in this generalized figure the extra points still describe loci of the same family, that I do not remember seeing demonstrated.

The fertile mind of Jacobi seized the germ idea of periodicity in this closed figure, so closely resembling sets of arguments of the elliptic functions differing by aliquot parts of a period. This suggestion was the more natural because of the geometrical diagrams current in the definition of elliptic arguments. Only six years after the date of Poncelet's book, we find (1828) in Crelle's *Journal,* Vol. III., Jacobi's brief and elegant essay on these polygons for the

case of two circles. Steiner had but recently written on the same topic, apparently unaware that it had been approached before. Jacobi was able now in the light of Poncelet's theorem to vindicate the claims of Fuss to priority, since his *irregular-symmetric* polygons were particular cases in every infinite set of Poncelet polygons on the same pair of circles. Jacobi further applies the recursion formulæ arising in the iterated addition of a constant to the elliptic integral of the first kind. Note his compact and expressive formulæ. If the radii are R and r, the distance of their centers a, and the n-gon encircles the centers i times before closing, all this is duly contained in the three formulæ

$$\int_0^{\alpha} \frac{d\varphi}{\sqrt{(1-kk\sin^2\varphi)}} = \frac{i}{n}\int_0^{\pi} \frac{d\varphi}{\sqrt{(1-kk\sin^2\varphi)}};$$

$$\cos\alpha = \frac{r}{R+a};$$

$$kk = \frac{4aR}{(R+a)^2 - rr}.$$

By this apparatus he verified the conditions already calculated for the closure in 3, 4, 5, 6, 7 sides, and confirmed for 8 sides the result of Fuss in opposition to Steiner's formula.

Certainly there is something satisfactory in seeing similar steps in geometric construction replaced by successive additions of one fixed quantity to an elliptic argument. But the problem was originally one of algebraic geometry, in so far as the conic represents a quadric form and the conditions of incidence and contact are algebraic; hence it was to be expected that there would be investigators who would not be satisfied with this transcendental elucidation of Jacobi, but would insist upon algebraic treatment throughout. Moreover, when once the projective treatment of figures had acquired prestige in pure geometry, it made inroads rapidly in the analytic territory. It was then desirable to solve the problem in its generality, for two conics whose equations are given arbitrarily, not restricting them to be circles; and to use processes and nomenclature that would not be affected by linear substitutions upon the coordinates or collineation. These last two desiderata appealed to Cayley not long after 1850, and from time to time he worked out parts of the problem: to express in invariants of two quadrics the condition that a broken line inscribed in the one and circumscribed to the other shall close in n sides. The results are not stated in terms of *rational* invariants, but they have the very great merit of being quickly and easily perceived, and of requiring only invariant terminology. The discriminant of a quadric is perhaps the best known of all invariants. For a quadric with one linear parameter he requires the discriminant to be calculated—namely for $F + K\phi$, where $F=0$ and $\Phi=0$ are the equations of the two conics, respectively. This is of degree 3 in the parameter.

$$D = A + bK + cK^2 + dK^3.$$

Next, the square root of this discriminant is developed formally in ascending powers of K;

$$\sqrt{D} = \sqrt{A} + B_1K + B_2K^2 + C_1K^3 + C_2K^4 + D_1K^5 + D_2K^6 + \text{etc.}$$

The conditions of closure are now, in form at least, simplicity itself, namely, the vanishing of a determinant whose constituents are coefficients in this development. For an odd number of sides in the polygon, the leading constituent is C_1; for an even number, C_2, thus:

For 3 sides,

$$C_1 = 0,$$

For 5 sides,

$$\begin{vmatrix} C_1 & C_2 \\ C_2 & D_1 \end{vmatrix} = 0,$$

For 7 sides,

$$\begin{vmatrix} C_1 & C_2 & D_1 \\ C_2 & D_1 & D_2 \\ D_1 & D_2 & E_1 \end{vmatrix} = 0;$$

For 4 sides,

$$C_2 = 0,$$

For 6 sides,

$$\begin{vmatrix} C_2 & D_1 \\ D_1 & D_2 \end{vmatrix} = 0,$$

For 8 sides,

$$\begin{vmatrix} C_2 & D_1 & D_2 \\ D_1 & D_2 & E_1 \\ D_2 & E_1 & E_2 \end{vmatrix} = 0, \text{ etc.}$$

When one of these conditions is satisfied, the corresponding polygons are inscribed in the conic $\Phi = 0$, and circumscribed to the other. To test two given conics by this method would evidently involve considerable labor, but it would have the merit of being straightforward work, all of one kind—the calculation of determinants. Only one such would enter, the square root of the discriminant of the conic that carries the tangents, hence rationalization would be easy. It is hardly likely that results more elegant will be reached by any method; yet there are later researches, that I have not yet been able to examine, highly praised by reviewers. It does not appear that Cayley has given any account of the modifications necessary in these conditions when the sides touch different curves of the pencil.

Two other questions, however, were started by Cayley. The first is that of the relations in terms of the two invariant cross-ratios of the two conics—those belonging to the four common points or the four common tangents in the one conic and in the other. Conditions that exhibit a recursive law of formation in one domain of rationality are quite certain to do the same in a different domain, and Halphen has carried out the solution of this problem to completion (if that is a possibility) in his Elliptic Functions, Part 2. His interest in the geometry of the figure led him to propose the question, How many conics in a *linear system* can serve as loci for the vertices of a polygon of m sides, the sides to be tangent to a fixed conic? The answer is, for a polygon of 3 sides, 2 conics; for 5 sides, 6 conics; for 6 sides, 6 conics; in general

$$\frac{m^2}{4}\left(1-\frac{1}{p^2}\right)\left(1-\frac{1}{q^2}\right)\left(1-\frac{1}{r^2}\right)\cdots,$$

where all the prime factors of m are p, q, r, etc.

Cayley's second new problem in this connection was one concerning curves other than conics. If m_i denotes the order; μ_i the class of any curve, and it is required to describe a closed polygon beginning from a vertex A upon a curve of order m_1, drawing a side that shall touch a curve of class μ_1 and meet in a second vertex a curve of order m_2, and so on, then the number of solutions is twice the continued product of the m's and the μ's. This implies that the curves are all different, and calls for modification when coincidences are required.

Cayley initiated, but Hurwitz carried to completion, an algebraic explanation of the mobility of the Poncelet polygon whenever it actually exists. This, which is much the simplest method of attack, is by means of a correspondence upon a rational curve or line. The conic is a rational curve, and its points or its tangents can be given by quadric functions of a single parameter. In the presence of a second conic to carry the tangents, any point of the first corresponds primarily to two others, namely those two points in which the first conic is cut again by tangents to the second conic drawn from the first point. Such a correspondence is symmetrical two-to-two or (2, 2). Points further removed from any given first point are related to it secondarily, or more remotely, by a derivative

(2, 2) correspondence between the parameters. Hence there should be $2+2$ closures, whatever the degree of remoteness demanded between first and last points. But exactly four, improper indeed, are supplied by the participation of the four common points or the four common tangents. The relevant algebraical equation for the parameters will always have four roots relating to improper or degenerate polygons. If it has any more than these four, it admits all parameter-values as roots. Hence one actual *proper* polygon of m sides proves the existence of countless others. This brief but conclusive reasoning gives the problem its true setting in advance, but leaves for other methods the question of the existence of the all-important *first proper* polygon.

Gino Loria, in his memorable work, *Il passato id il presente delle principali teorie geometriche,* makes mention of these papers of Hurwitz at the climax of his paragraphs on theorems of closure; and says of the earlier essay, that in it "we do not know whether to wonder more at the immensity of the view, or at the perfection of its beauty; and so with this we bring to an end this digression, for which we should seek in vain a close more worthy." I have preferred however to summarize it earlier, in order to make clear with the greater brevity certain other applications that depend upon the same principle.

It is hardly needful to remind you that the (2, 2) correspondence leads inevitably to elliptic functions, as Euler long ago pointed out. If we picture the situation by means of a Riemann surface, it must have two leaves and four branch-points; and is therefore of deficiency one, whence all functions belonging to the surface are doubly periodic. Of course in the foregoing survey we have been thinking mainly of real points and lines and loci, and so have neglected the second period—the first being real. The use of elliptic functions enables us to understand the situation involving imaginary arguments, as when the point locus is completely enclosed by the line-locus, so that a *real* polygon is obviously impossible, and yet the invariant conditions may be satisfied. The one essential premise is in every case, that the things under consideration are algebraically connected, two values of either to every one value of the other.

First let me recall the chain of circles devised by Steiner, most recently so interestingly treated by Professor Emch by the aid of his mechanical linkages. Let two circles enclose a ring-shaped area in the plane, and draw any one circle in that ring tangent to the first two. Let a second be drawn touching both the directors and the last mentioned circle, then a third touching in the same way the second, and so on. If a last circle ever appears in the series, say the nth in order, touching the first one, call the chain closed. This chain is now like the Poncelet polygon in the essential feature, in that every member (circle) is preceded by one and followed by one definite member of the series: the correspondence is certainly algebraic and (2, 2). Therefore the chain will close with n circles, no matter what one be selected for the first. Both Hurwitz and Emch have stated weaker conditions that lead to the same conclusion; but it would seem, if the analogy of the polygon porism is valid, that many other variations of conditions ought yet to be attempted.

There are Steiner's polygons on a plane cubic, with alternate sides passing through one of two selected fixed points on the curve. This curve, with points represented in elliptic functions of a parameter, might seem out of place among conics and other rational curves, but the next example will

remind us of the natural connection. Let the base points be A and B. Choose at random a point 1 on the cubic curve, and draw in their order the lines $A12$, $B23$, $A34$, $B45$, etc., all the numbered points lying on the curve. If this series never closes, the same would be true if point 1 were chosen elsewhere; or if it does close after $2n$ sides, the same will be true for every position of point 1. Here of course the relation of the base points is decisive, and the fact that elliptic arguments of three points in a line sum up congruent to zero makes the proper choice of the point B a mere matter of arithmetic, *i. e.*, division of a period of the functions for that cubic curve.

Projection from any point of a twisted quartic curve gives in the plane a cubic curve. But also from one of four special points, the quartic projects into a conic double. At the same time the generators of any quadric surface containing the quartic curve are projected into tangents of a second conic. Any Poncelet polygon of $2n$ sides on those two conics is then the projection, if we please, of a system of generators from the two families on the quadric, alternating, n from each family. On the plane cubic the same set of lines would be projected from a point P as the alternating sides of a Steiner polygon, where points A and B are projected by the two generators through the point P. As all generators of one family meet every generator of the other family, this makes clear the intimate connection between Steiner's and Poncelet's polygons.

To vary the object, look at Hurwitz's plane quartic curve with two cusps and a node. It has two inflexions and a double tangent, and is therefore of class 4, dual to itself. On such a curve let a tangent be drawn, and through each intersection with the curve the second possible tangent from that point; we have clearly another (2, 2) correspondence, and are prepared for the discovery that closure in a finite number of sides, starting from any one tangent or vertex, implies closure in the same number of sides, whatever the point of beginning. In place of two conics we have here the one quartic, but the essential (2, 2) correspondence is in evidence, and the same mobility of figure results from it.

Not to be confounded with these examples is the particular plane quartic curve investigated by Lüroth, which admits the inscription of a complete pentagon. There is a resemblance, it is true, in the fact that it too is a problem of closure, and in the variability of the pentagon. For if the sides of one such pentagon are given by equations, $p=0$, $q=0$, etc., so that the quartic equation is

$$pqrs + qrst + rstp + stpq + tpqr = 0,$$

then these five sides are tangents of a unique conic, and every tangent to that conic is one of a set of five constituting an inscribed pentagon of the same quartic. But the correspondence is (4, 4), and the circumscribed locus is not a rational curve. It is, however, in one direct line of descent from Poncelet's triangles. Those triangles mark, on the conic-bearing tangents, sets of three points in involution; and any cubic involution of tangents has for locus of the vertices of its triangles a second conic. So when the number of tangents in each set is increased, we have the *involution-curves*. It is an involution of the fifth order which generates for its locus this quartic curve of Lüroth, each tangent intersecting the four in its own set. Such an involution is the equivalent of a (4, 4) correspondence, which might in special cases degenerate into two (2, 2) correspondences, and carry Lüroth's quartic curve with it into two distinct conics, each containing a system of inscribed Poncelet triangles.

A somewhat different kind of curve arising from a (2, 2) correspondence was that investigated some years ago by Holgate. Starting with a pencil of conics, normalized to a system of coaxial circles, he gave to every point in their plane an index, usually ∞, but for certain points finite. From the point any line is drawn. It touches two circles of the system. One of these has a second tangent through that same point, and that tangent touches a third circle, etc. If after n steps of this kind the first line is reached again, the index of that point is n. Holgate determined the locus of points whose index is 3 as a parabola; that for index 4 as a nodal quartic, and laid out the general method for higher indices. One should react from this experiment to something more like the original Poncelet object; to one fixed conic as support of its tangents, and a double infinity or net of conics. A simple infinity of conics in this net would contain Poncelet triangles with respect to the fixed conic: their index would be 3, and their envelope would take the place of Holgate's parabola. And for the dual problem, there is ready at hand the well-known system of confocal conics, in which the indices of all straight lines should be studied, and the envelopes of lines for each integral index.

The number of different treatments of this same problem increases, not rapidly, but steadily; its fascination is exerted upon the successive generations of mathematicians, and some of their works of art stand out from the mass, some for a little time, some longer. I shall pass over most of them, these images, in geometric shape, of the algebraic (2, 2) correspondence; and describe only one more related object, an image of a (3, 3) correspondence. Franz Meyer studied it and elaborated it in detail, years ago as a docent at Tübingen, in his book on *Apolarität*. Studying the quartic involution, he began with the (3, 3) correspondence among points upon a twisted cubic curve, the simplest rational curve in space of three dimensions. For comparison, remember the cubic involution on a conic in two-space. There we had this theorem on Poncelet triangles: If a conic be circumscribed to one triangle which is circumscribed about a fixed conic, then there are ∞^1 other triangles similarly related to the two conics. Meyer found the theorem, surprising by contrast: If a tetrahedron be formed of four planes which osculate one fixed cubic curve in three-space, and a second cubic curve be passed through its four vertices, then that pair of cubics may have, or *may not have*, a second tetrahedron similarly related to them. If, however, there is a second tetrahedron, then there is a simply infinite set of such. Many other remarkable facts in the geometry of twisted cubic curves he developed, most of which still wait for diffusion among the geometric public.

Such a discrepancy between conic and cubic does not exist in regard to periodic sets of lines and planes, respectively, of period seven. Whether it is found for periods five and six, no one has yet undertaken to determine. Yet a cleavage so marked, and so unexpected, is certainly a challenge to geometricians to explore further the so-called *norm curves* of hyperspace, and the involutions of point sets of low orders upon them.

Also the half-forgotten fact deserves recognition and exploitation, that all those Poncelet systems are associated with *linear involutions* upon rational curves. In that feature, possibly, lies even more promise of generalizations and discoveries than in Jacobi's brilliant and beautiful depiction by the aid of periodic functions.

Not every creation of the geometric mind finds an environment ready in which it can

live and grow. Some remain, immortal but alone, like the ancient theorem of Pythagoras or perhaps in recent years Morley's Pentacle, that creation of tantalizing beauty and illusory simplicity. Most new ideas in geometry die early, or pass, by publication, into the condition of mummies or fossils; let our grateful recognition and praise follow then those fortunate worthies like Poncelet, whose genius has given us the fruitful ideas, problems and theories with a significance stretching far beyond their accidental first form, reappearing through the years in new embodiments, and so achieving a life if not perpetual, at least as long enduring as the present era of intellectual culture.

H. S. White

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THE CONTEST WITH PHYSICAL NATURE[1]

I fancy that if Christopher Columbus is able at this time to survey this world and see what is happening that he is well pleased at his venturesome voyage. While the nations of the world that he left have their knives at each other's throats the peoples of this new world have sent their most learned men, their philosophers, their scientists, inventors and engineers to talk with one another as to how this new land may become wiser, richer and be made more useful. This is surely a contrast. It is a condition for which my knowledge of history offers no parallel.

There are times I know when nations who believe in themselves must fight. But let us not delude ourselves with the notion that civilization is the product of arms. The only excuse for war is to secure peace, that men of thought, resourcefulness and skill may have opportunity to make themselves masters of the secrets of nature.

For the real battle of the centuries is not between men or between nations or between races. The one fight, the enduring contest, is between man and physical nature.

There is no denying the fact that we live in a world that is hostile and secretive. It is organized to destroy us if it can. Our enemies have cunning and ferocity. We have but to fold our arms and the beasts, the flies, the rats, the mosquitoes and the vermin would make us their easy prey. And if they could not win by force, they would bring death by starvation. This world was made for a fighting man and for none other. Softness is not to be our portion, because nature knows no holiday. So man must battle with nature that he may secure that physical peace necessary to give his spirit a chance to show itself in things of beauty and deeds of goodness.

And this is what we call civilization—this triumph over the down-pull of nature. We make her yield. We master her secrets. With wooden club and stone axe, with bow and arrow and with fire man mastered his wild enemies and then with seed and water man mastered the surface of the earth. The sea challenged him and he discovered the floating log, the paddle and then the sail, until he made himself master also of the surface of the sea. These things it took ages to do. Nature revealed nothing. Man had to observe and reflect that he might discover or invent. Was there ever such a discovery as that a planted seed would sprout and yield? Or that the wind would drive a hollowed log?

But these things happened long ago. And now we have made not only the surface of the land and sea our own, but their depths as well. The wind not only fills our sails, but we master the air itself. We make our own lightning and harness it to work for us, to push and to pull, to lift and to turn. We have found the great secret that nature can be made to fight nature. But we must fight with her for our weapons. They are not handed to us; they are hidden from us. If man is to have dominion over this earth, he is committed to an unending search. He must bore and burrow, dig and blast, crush and refine, distill and mix, burn and compress until he forces nature to yield her locked and buried treasures.

[1] Address before the Mining and Geological Section of the Pan-American Scientific Congress.

Nature would have man isolated, but he triumphs over her with billets of steel and threads of copper. He swings a hammer and an engine is made that makes him neighbor to the world. He whispers to a wire which shouts the spoken word into space.

Nature would have a limit to the soil's supporting strength, but man robs the air of its nitrogen and the rocks of their phosphorus and potash to revivify the unwilling earth.

Nature would have man the victim of insidious enemies that stop or clog the human machine, but man distills from the buried carbons agents that stay destruction for a time, and now man has found a mineral which gives promise of opening the way into a new world of mysterious restoration.

This is a glorious battle in which you are fighting—the geologist who reads the hieroglyphs that nature has written, the miner who is the Columbus of the world underground, the engineer, the chemist, and the inventor who out of curiosity plus courage, plus imagination fashion the swords of a triumphing civilization. Indeed it is hardly too much to say that the extent of man's domain and his tenure of the earth rest with you.

F. K. LANE

DEPARTMENT OF THE INTERIOR

DANIEL GIRAUD ELLIOT

IN the death of Daniel Giraud Elliot, which occurred on December 22 last, after a short illness from pneumonia, science has lost a distinguished ornithologist and mammalogist. Dr. Elliot was born in New York City, March 7, 1835, and had therefore nearly completed his eighty-first year. He prepared to enter Columbia College in the class of 1852, but delicate health prevented his taking a college course and led him to seek for several years a mild winter climate, during which he visited southern Europe, Egypt, Palestine, Turkey, the West Indies and Brazil. In 1906 he was honored by Columbia University with the degree of Sc.D. From an early age his interest in natural history was intense, and in its pursuit he traveled widely and spent many years in Europe, chiefly in Paris and London. For some years before his death he was the dean of American zoologists, exceeding in age his lifelong friend, Dr. Theodore N. Gill, by two years. His primary interest for many years was ornithological, and he was the author of many folio monographs of birds, expensively illustrated with handcolored plates; during the last twenty years he devoted his time to the study of mammals, which became almost exclusively the subject of his researches.

In his early days he formed a notable collection of North American birds—the best private collection then extant—which later was secured by the American Museum of Natural History, forming its first collection of birds and the nucleus of its present magnificent collection. At this time (in the later sixties) George N. Lawrence, a much older man than Elliot, was the only working ornithologist in New York, while John Cassin, of Philadelphia, and Professor S. F. Baird, of Washington, were the only other prominent ornithologists in America.

Dr. Elliot's first publication of note was his "A Monograph of the Tetraonidæ, or Family of the Grouse" (New York, 1864–1865), a work in imperial folio with 27 handcolored plates. This was followed two years later by "A Monograph of the Pittidæ, or Family of the Ant Thrushes" (New York, 1867), also in folio with 31 colored plates. Soon after appeared his "The New and Heretofore Unfigured Species of the Birds of North America" (New York, 1866–1869), in two imperial folio volumes with 72 colored plates. These were soon succeeded by "A Monograph of the Phasianidæ, or Family of Pheasants" (New York, 1872), also in two folio volumes with 48 colored plates. These works, mainly illustrated from his own drawings, were all brought out in America and their preparation marks the period prior to his long sojourn abroad, beginning in 1869, where similar magnificent works were prepared and published in London. These are: "A Monograph of the Paradiseidæ, or Birds of Paradise" (folio, London, 1873, with 37 colored plates); "A Monograph of the Bucerotidæ, or Hornbills" (folio, London, 1876–1882, with 59 colored plates); "A Mono-

graph of the Felidæ, or Family of the Cats" (folio, London, 1883, with 43 colored plates). These works were not only important contributions to science but as works of art were at the highest level of such publications and rendered their author famous throughout the world, winning for him many decorations from European governments. He was himself an artist of no ordinary attainments, but he sought for his illustrations the best talent available abroad, including such eminent draughtsmen as Wolf and Keulemans.

During this period of nearly ten years abroad he was a frequent sojourner in Paris, in order to avail himself of the rich treasures of the famous natural history museum of that city, and became thus intimately associated with many of the leading French zoologists. Through his long residence in London he participated in the scientific activities of the British Ornithologists' Union and the Zoological Society, and for a time was a member of the Publication Committee of the latter. In his recent "In Memoriam" of the late Philip Lutley Sclater,[1] for so many years the efficient secretary of the Zoological Society and also editor of *The Ibis,* he has given a most enchanting reminiscence of the great naturalists who were in that day at the height of their activities and renown, but who have now, with the single exception of F. Ducane Godman, preceded Elliot to the great beyond.

Although the labor of getting up his great illustrated monographs must have been absorbing, he found time to prepare many technical papers on birds, which were published at frequent intervals in *The Ibis* or in the *Proceedings* of the London Zoological Society. At this time he was especially interested in the Trochilidæ, or Hummingbirds, the outcome of which was his "A Classification and Synopsis of the Trochilidæ," a quarto memoir of about 300 pages, with numerous text illustrations, published in the *Smithsonian Contributions* (Washington, 1879).

Elliot's active temperament never permitted him to remain long idle. Soon after his return from abroad he became one of the authors of the "bird volume" of Kingsley's "The Standard Natural History," published in 1885, to which he contributed the parts on the Gallinæ, the pigeons and the hummingbirds, and also began work on a new edition of his "Monograph of the Pittidæ." Since the publication of the first edition in 1863, the number of species of the group known to science had nearly doubled, and in preparing the new edition the text of the first was wholly discarded, only a few of the plates being retained in the second, which now included 51 colored plates with wholly new and greatly extended text. It was published in London by Quarich (1893–1895).

Another outcome of his long interest in the Trochilidæ was the formation while abroad of a collection of these "gems of ornithology," which he brought with him on his return to New York early in 1883. This collection, then probably unsurpassed by any other, he later (in 1887) presented to the American Museum of Natural History, where it has since remained as a standard reference collection for the group. At about this date Dr. Elliot's extensive and well-selected ornithological library passed to the museum by purchase. It contained many rare as well as expensive works, and for the first time the museum came into possession of a reasonably adequate library of ornithology.

In 1894 Elliot became curator of zoology at the Field Columbian Museum at Chicago, from which office he resigned in 1906 and returned to New York. During his curatorship at this institution the zoological department at the Field Museum made rapid strides through his energetic efforts, and it was also a period of marked activity in his literary career. In 1896 he made an expedition to Africa in the interest of this museum, passing through Somaliland and Ogaden on his way to the Boran country, where his work was checked by serious illness. He succeeded, however, in bringing back a large collection of birds and mammals, which became not only the basis of important exhibits in the museum but of important papers giving the results of his explorations. He later made a difficult

[1] *The Auk,* XXXI., January, 1914, pp. 1–12.

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expedition to the Olympic Mountains in Washington, also fruitful in zoological results.

During his curatorship at the Field Museum he prepared and published under its auspices several important handbooks on North American mammals, an undertaking that might well have taxed the courage and energies of a much younger man. These are: "Synopsis of the Mammals of North America and the Adjacent Seas" (1 volume, large 8vo, 1901); "The Land and Sea Mammals of Middle America and the West Indies" (2 vols., large 8vo, 1904); "A Check List of the Mammals of the North American Continent, the West Indies and the Neighboring Seas" (1 vol., 8vo, 1905); "A Catalogue of the Collection of Mammals in the Field Columbian Museum" (large 8vo, 1907). The first two of these works form a handbook to all the mammals of North America and adjacent islands, with the cranial characters of each genus well illustrated by excellent half-tone cuts of natural size, while the text gives brief descriptions and full references to the original descriptions. While open to criticism, as such work must always be, they have proved of great utility not only to amateurs but to experts.

On leaving the Field Museum he set out upon a work of so much difficulty and magnitude that it seemed an almost audacious undertaking, which some of his friends feared would prove beyond his strength. This is his "A Review of the Primates," begun in 1906 and completed in 1912, and published in three volumes by the American Museum of Natural History, with 11 colored plates of animals and 32 half-tone plates of skulls, the latter all natural size, and with a perfection of detail not previously attained. Soon fully realizing the seriousness of the undertaking he sailed for Europe in April, 1907, to visit all of the principal museums abroad in order to study the actual types of the species and such other material as bore upon the subject. After visiting the museums and zoological gardens of Europe he passed on to Egypt, India, China and Japan, returning to New York after an absence of eighteen months, with an immense store of notes and manuscripts for future elaboration. After the work had greatly progressed he found it necessary to revisit the museums of Europe to settle many still doubtful points. He labored at his great task incessantly for at least nine months of each year, year after year, with indomitable industry and perseverance till at last it was completed for the press. In a work of this nature it would be rash to expect perfection; it is essentially sound in principle and method, and if lacking somewhat in details, it will long be of invaluable service to all who may follow in the same field.

Besides the works already mentioned, Dr. Elliot has many lesser volumes and a long list of technical and occasional papers to his credit. During the years 1895–1898, he published three casual volumes, of a somewhat popular character, on the game birds of North America, for Elliot was an ardent sportsman as well as a naturalist. These books, which have met with much favor, are entitled: "North American Shorebirds: a History of the Snipes, Sandpipers, Plovers and their Allies" (8vo, New York, 1895); "The Gallinaceous Game Birds of North America" (8vo, New York, 1897); "The Wild Fowl of the United States and British Possessions, or the Swans, Geese, Ducks and Mergansers of North America" (8vo, New York, 1898).

Dr. Elliot was one of the founders of the American Ornithologists' Union (1883), its president for two years (1890–1891), and an active member of its council for twenty-eight years (1887–1915). He was also a member of the British Ornithologists' Union, the Zoological Society of London, a fellow of the Royal Society of Edinburgh, and an honorary or corresponding member of many scientific societies in Europe as well as in America.

In the early years of the founding and organization of the American Museum of Natural History Dr. Elliot greatly aided the trustees by his wise scientific advice—at that time the only resident naturalist in New York equipped with the requisite experience and technical knowledge—and acted as their agent for several years in Europe in the pur-

chase of the important collections which formed the foundation of its present strong departments of mammalogy and ornithology. He has in later days shown his keen interest in its welfare through valuable gifts and appreciated advice.

On the occasion of his eightieth birthday, the American Museum made public recognition of his services through the publication of a brief biographical sketch of Dr. Elliot with portraits of him at the age of thirty years, at sixty-four (when curator of zoology at the Field Museum), and at eighty, and presented him with an engrossed memorial signed by the full scientific staff of the museum, giving him "greeting with grateful recognition and appreciation" of his services "as an expert adviser of the museum in its early days." A few months later he was elected to the board of trustees, from which his sudden removal by death is regarded as a great loss to the institution.

Dr. Elliot was not without further special honor in his home city. On March 24, 1914, the Linnæan Society of New York held a dinner in his honor in recognition of "his unique attainments in mammalogy and ornithology," at which the society presented him with its Linnæan medal of honor, the second occasion of the presentation of this medal. Dr. Elliot's speech of acceptance was in his characteristically graceful and happy vein. It was soon after published by the society as a special brochure.

Dr. Elliot was a man of striking personality, dignified and reserved in manner, conservative yet broadminded, constant and sympathetic in his personal friendships. His career was one of ceaseless activity in his lines of special research, and he has left many monuments to lighten the way of those who may follow in his footsteps. He fell into no ruts of routine that materially hampered his progress. On leaving England he was naturally deeply embued with the ways and methods of his British confrères, particularly in certain nomenclatorial matters, but these he was able to promptly abandon, accepting in their place the then radical innovations that had arisen in his home land during his absence. In other words, he soon accepted the A. O. U. Code of Nomenclature, with the date of Linné at 1758 instead of 1766, its trinomialism, and the point of view regarding species and subspecies thus entailed, which many of his colleagues of the earlier days of his sojourn abroad could never bring themselves to adopt.

Dr. Elliot was the fourth son of George T. and Rebecca Giraud Elliot. He was descended on his father's side from old Connecticut stock which settled near New London early in the sixteenth century, and on his mother's side from French ancestors who settled at New Rochelle and later moved to New York some two centuries ago. On the paternal side his forebears were prominent in public affairs, and in the colonial wars against the Indians. He was married in 1858 to Annie Eliza Henderson, by whom he had two daughters, of whom one, Margaret Henderson Elliot, still survives.

J. A. Allen
American Museum of Natural History,
New York

FRANCIS MARION WEBSTER

Science has suffered an irreparable loss and the entomological confraternity a severe shock in the death, by pneumonia, of Professor F. M. Webster, in charge of cereal and forage insect investigations in the U. S. Bureau of Entomology. The sad event occurred on January third at Columbus, Ohio, where he had gone in order to attend the meetings of the American Association for the Advancement of Science.

Francis Marion Webster was born at Lebanon, New Hampshire, August 8, 1849, and was therefore in his sixty-seventh year. His first entomological writing occurred in the *Chicago Weekly Interocean,* July 2, 1874, under the title of "Notes on Some of the Common Injurious Insects." He was appointed assistant state entomologist of Illinois in 1882 and served in that capacity until 1884, publishing several short but interesting and important papers on insects affecting cereal and forage crops. Professor Webster served

as special field agent to the U. S. Department of Agriculture from 1884 to 1892 and at other various times in his career. It was during the period mentioned above that he conducted the very important investigations on the buffalo gnats in Mississippi and Louisiana, resulting in the discovery of the conditions necessary for the maintenance of the larval existence of these pests, thereby paving the way for the institution of remedial measures eventually resulting in immense savings of money in the form of live stock, to say nothing of the assuagement of human misery.

In 1888 Professor Webster was detailed by the late Dr. C. V. Riley, then chief of the U. S. Division of Entomology, to visit Australia for the purpose of making a report on the agricultural features of the Melbourne International Exposition, the U. S. Exposition Commissioners making the preparation of this report conditional upon their agreement to assume the expense of the journey for both Professor Webster and another entomologist, Mr. Albert Koeble. The latter was charged with the work of collecting the natural insect enemies of the citrus fluted scale, which had accidentally become introduced into California, resulting in the discovery of the wonderfully efficient Coccinellid beetle, *Vedalia cardinalis*. Professor Webster visited portions of Australia, Tasmania and New Zealand, accomplishing his mission with eminent success and returning to this country in 1889.

During the years 1891 to 1902 he was entomologist to the Ohio State Experiment Station. This portion of his life was productive of much important biological research work and many valuable observations, not the least of which were his discoveries of the relations of ants to the existence of the corn root aphis, and those which resulted in his memorable paper on the Hessian fly, setting forth the now well substantiated theory to the effect that wheat should be planted subsequent to the emergence and death of the great bulk of adult flies in the autumn, resulting undoubtedly in the saving of vast sums of money to the progressive farmers of the entire wheat belt. During a portion of the years 1903–04 Professor Webster was connected with the Biological Survey of Illinois but his more important work was in the capacity of special field agent to the United States Department of Agriculture. The results of these investigations were made known in several bulletins of the old Division of Entomology. The most important of these is perhaps the paper entitled "Some Insects Attacking the Stems of Growing Wheat, Rye, Barley and Oats," regarded as a standard publication of its class for many years.

At the end of 1904 Professor Webster came to Washington to join the entomological service of the Department of Agriculture which had just been given bureau rank. The section of Cereal and Forage Insect Investigations was created in 1906 and Professor Webster placed in charge, which position he held at the time of his death. In this service the climax of his usefulness was attained. He started this work with a single assistant but under his masterly guidance its organization developed with giant strides until at the time of his death a staff of more than fifty trained entomologists were carrying out his plans and the section received from congress for the fiscal year 1915–16 an appropriation of $114,500. Professor Webster's life was a most industrious one. His hundreds of valuable papers dealing almost exclusively with the many phases of economic entomology will endure so long as the science of entomology itself.

Although recognizing fully the importance of taxonomic work in the field of biological science Professor Webster apparently never described a single genus or species, although he discovered many during his decades of biological research work. Several genera in hymenoptera and diptera have however been named in his honor by various authors. He evinced a tremendous interest in his work and was able through sheer force of character to transmit this quality to his entire staff of investigators, each one of whom was made to feel that his superior took a lively and intensely human interest not only in his work but also in him personally. The younger men will remember their lamented friend and chief

with especial gratitude for his kindly interest, generous viewpoint and sound advice. He evinced absolutely no trace of that petty jealousy regarding credits in the publication of results which mars the character of some otherwise truly big men in science. On the contrary, he was ever ready to sacrifice both time and labor in assisting his men in their efforts.

Professor Webster was a Fellow of the American Association for the Advancement of Science and the Indiana Academy of Science, and ex-president of the Association of Economic Entomologists, Ohio Academy of Science and the Entomological Society of Washington, a member of the Entomological Society of America, Biological Society of Washington, and the National Geographic Society. He was also an honorary member of the Entomological Society of Ontario and Corresponding member of the Cambridge Entomological Club and the New York Entomological Society. The degree of master of science was conferred on him by the University of Ohio in 1893.

Personally, Professor Webster was genial in manner, frugal and abstemious in habit and extremely simple in tastes; of exceeding honesty; in speech most temperate and he had acquired a literary style that was at once direct, lucid and forceful. He was also a most practical man, possessing a broad knowledge of agricultural methods and was therefore enabled to see his scientific problems from the viewpoint of the farmer. This latter faculty contributed as much perhaps as any one of his many excellent attributes toward the achievement of the magnificent success in economic entomology which was his.

Although Professor Webster's death occurred with shocking suddenness, he enjoyed a privilege granted to comparatively few men, in being permitted to spend nearly a half century in a labor he loved and to die at the very zenith of his usefulness and popularity in a manner which would very probably have been his choice, namely, "in the harness."

W. R. Walton

THE JOSEPH AUSTIN HOLMES MEMORIAL

A meeting was held in the Bureau of Mines, Washington, on January 15, 1916, at which the following were in attendance: Mr. Hennen Jennings and Mr. Van H. Manning, representing the American Institute of Mining Engineers; Dr. David T. Day and Dr. Joseph Hyde Pratt, the American Mining Congress; Mr. Samuel Gompers, the American Federation of Labor; Mr. William Green, the United Mine Workers of America; Dr. George Otis Smith, the Mining and Metallurgical Society; Gen. W. H. Bixby, the American Society of Mechanical Engineers; Mr. John H. Finney, the American Institute of Electrical Engineers; Dr. F. G. Cottrell, the American Electro-Chemical Society; Mr. George S. Rice, the National Safety Council; Dr. L. O. Howard, the American Association for the Advancement of Science; Dr. S. S. Voorhees, the American Chemical Society; Dr. Charles D. Walcott, Mr. Nelson H. Darton and Dr. Joseph Hyde Pratt, the Geological Society of America; Dr. David White, the National Academy of Sciences; Major Robert U. Patterson, the American Red Cross Society, and Mr. William L. Hall, the American Forestry Association.

The object of the meeting was to consider a permanent memorial to the late Dr. Joseph A. Holmes, the founder of the United States Bureau of Mines. After an extended discussion, the following resolutions were adopted:

Whereas, it is the sense of this meeting that a suitable memorial be established to honor the memory of the distinguished humanitarian and scientist, Dr. Joseph A. Holmes, therefore be it

Resolved, First, That each national body or society here represented and others that desire to be represented be requested to approve a permanent organization or incorporation to be known and named "The Joseph A. Holmes Safety First Association," and that each such national body or society shall appoint one representative to act with other representatives in such permanent organization.

Resolved, Second, That a meeting be held of the duly appointed representatives of the Bureau of Mines building, Washington, D. C., on March 4,

1916, at which a permanent organization is to be effected.

Resolved, Third, That pending the formation of a permanent organization the temporary officers continue together with two members to be appointed by the chair as an executive committee with authority to incur necessary expenses, and that the temporary officers be authorized and empowered to take all necessary action in furtherance of the purposes of the permanent organization.

Resolved, Fourth, That the proposed organization when so effected shall through its various members and organizations endeavor to collect sufficient funds to carry out the purposes of this association.

Resolved, Fifth, That each national body or society becoming a member of this organization shall select its representative and notify the temporary secretary of such membership and selection.

Resolved, Sixth, That the temporary organization commends to the permanent organization the annual award of one or more medals which, together with honorariums, shall be termed The Holmes Award for the encouragement of those originating, developing and installing the most efficient "safety first" devices, appliances or methods in the mineral industry and also special medals for the recognition of personal heroism or distinguished service in the mineral industry. However, further suggestions are invited from the organizations to be represented in this association.

SCIENTIFIC NOTES AND NEWS

PROFESSOR STEPHEN ALFRED FORBES, of the University of Illinois, and Professor Samuel Wendell Williston, of the University of Chicago, were elected honorary fellows of the Entomological Society of America at its meeting at Columbus, Ohio.

DR. P. A. LEVENE, member of the Rockefeller Institute for Medical Research and director of the chemical laboratories, has been elected an ordinary member of the Rega Societas Scientiarum Upsaliensis in recognition of his scientific activities.

THE Geological Society of London has made the following awards of medals and funds: Wollaston medal, Dr. A. P. Karpinsky (Petrograd); Murchison medal, Dr. R. Kidston, F.R.S. (Stirling); Lyell medal, Dr. C. W. Andrews, F.R.S. (Natural History Museum, London); Wollaston fund, Mr. W. B. Wright (Geological Survey of Ireland); Murchison fund, Mr. G. W. Tyrrell (Glasgow University); Lyell fund, Messrs. M. A. C. Hinton and A. S. Kennard.

THE faculty of Presidency College, Calcutta, has appointed Dr. J. C. Bose professor emeritus.

AMONG the members of the Assay Commission for the coming year, appointed by President Wilson, are Professor Jas. Lewis Howe, Washington and Lee University; Professor Andrew C. Lawson, University of California, and Dr. F. W. Clarke, U. S. Geological Survey. The commission will meet at the Philadelphia Mint February 9 to test the weight and fineness of the coins reserved by the several mints of the country during the past year.

A COMPLIMENTARY dinner was given to Professor Victor C. Vaughan, dean of the medical department of the University of Michigan, at the Harvard Club, New York City, by the faculty of the University and Bellevue Hospital Medical College, on January 12.

As has been already announced, Dr. John H. Wigmore, professor of law in Northwestern University, was elected president of the American Association of University Professors at the annual meeting. It is now announced that Professor H. W. Tylor, professor of mathematics at the Massachusetts Institute of Technology, has been elected to the secretaryship.

DR. W. H. PERKIN, F.R.S., professor of chemistry at the University of Oxford, has accepted the post of head of the research department of British Dyes, Limited. He has also accepted the chairmanship of the Advisory Council of that company, in the place made vacant by the death of the late Professor Raphael Meldola, F.R.S.

THE loss which the U. S. Geological Survey has suffered through the death of Mr. Sledge Tatum necessitates the following assignments in the topographic branch: William H. Herron to be acting chief geographer to serve for the balance of the fiscal year; Glenn S. Smith as topographic engineer in charge of the central division for the same period, and Claude

H. Birdseye as topographic engineer in charge of the Rocky Mountain Division. In case of the temporary absence of the branch chief the division chiefs will act for him with full authority, in the following order of seniority: Frank Sutton, T. G. Gerdine, G. R. Davis, C. H. Birdseye, G. S. Smith.

C. William Beebe, curator of birds of the New York Zoological Society, has sailed for British Guiana to establish a tropical zoological station. Mr. Beebe will build a bungalow on the edge of the jungle and there he will study the habits of birds in their own province. A complete laboratory outfit will be taken. With him will be Inness Hartley, who goes as research associate; Paul Holmes, whose interest is in photography and work with insects, and Mr. Carter, who goes as collector.

Professor Charles H. Tuck, of the college of agriculture, Cornell University, has left Ithaca on a sabbatic leave of absence which will extend to next September. He is on his way to Manchuria, where he is to make agricultural investigations.

Professor S. Nawaschin, for many years professor of botany in the University of Kiew, Russia, and also director of the botanical garden of that place, has gone to Tiflis. He wishes his botanical correspondents to note that his address is now Botanic Garden, Tiflis (Caucas), Russia.

The Frederick Forchheimer chair of medicine in the University of Cincinnati was formally inaugurated on January 28. President Charles W. Dabney made an address on Frederick Forchheimer and scientific methods; Dr. Christian R. Holmes, dean of the college of medicine, spoke on the history of the founding of the chair, and Dr. Roger S. Morris, recently appointed to the chair, also made an address.

Professor Lafayette B. Mendel, of Yale University, will give a course of three lectures at the University of Illinois on the subject of "Some Features of Growth," February 10, 11 and 12. He will also be a speaker at an assembly of the College of Agriculture, when he will speak on the topic, "Changes in the Food Supply and Their Relation to Nutrition."

Before the New York Electrical Society on January 27, Professor Michael I. Pupin, of Columbia University, gave an address on "Wireless Transmission Problems."

The Lettsomian lectures before the Medical Society of London will be delivered by Major F. W. Mott, F.R.S., on February 7 and 21 and March 6, the subject selected being the effects of high explosives on the central nervous system.

The late Professor Meldola bequeathed his entomological collection and cabinets to the Hope Museum, Oxford. If there are no grandchildren £500 each is to be paid to the Royal Society, the Chemical Society, the Entomological Society and the Institute of Chemistry of Great Britain and Ireland.

A gift of $2,000 has been made to Cornell University by Professor Simon H. Gage and his son, Henry Phelps Gage, to provide for the construction of a room in a new dormitory for women students. The gift is made as a memorial to Susanna Phelps Gage (Mrs. Simon H. Gage), author of valuable contributions to embryology and comparative anatomy.

The Medical Society of the District of Columbia and the Association for the Prevention of Tuberculosis of the District held a joint meeting on January 19, in memory of the late Surgeon-General George M. Sternberg, U. S. Army. Addresses were delivered by Drs. George M. Kober, William C. Gwynn and Harvey W. Wiley.

Mr. Sledge Tatum died on January 18 after a long service with the Geological Survey. He was a topographer from 1899 to 1904. He then served on the Isthmian Canal Commission for four years, when he returned to the Geological Survey as topographic engineer and was appointed geographer of the Rocky Mountain Division in 1910. A short time prior to his death he was appointed acting chief geographer. Mr. Tatum's services to the government have been of a high order. He had ability and enthusiasm for his work and a personality which enabled him to secure loyal and efficient service from his associates.

THE death is reported of Mr. T. L. Wilson, of Ottawa, Canada, known for his inventions concerned with acetylene gas and carbide.

SIR CLEMENTS MARKHAM, who took part in the Arctic expedition of 1850 in search of Sir John Franklin, and subsequently engaged in many geographical explorations, president of the Royal Geographical Society from 1893 to 1905, died on January 30, at the age of eighty-six years.

SIR FRANCIS HENRY LOVELL, dean of the London School of Tropical Medicine, died on January 28 in London. Sir Francis had been chief medical officer of Mauritius and a member of the legislative council and he had served as surgeon-general and as a member of the executive and legislative councils of the colonies of Trinidad and Tobago.

SIR H. EVELYN OAKELEY, author of mathematical works and reports on educational subjects, has died, aged eighty-two years.

GRAF ZU SOLMS-LAUBACH, who held the chair of botany first at Göttingen and afterwards at Strasburg, has died at the age of seventy-two years.

GUIDO BACCELLI, professor of clinical medicine at the University of Rome and chief of the general hospital, the Policlinico, the erection of which was mostly his work, has died, aged eighty-four years.

THE New York Academy of Sciences will celebrate in May, 1917, the centenary of its foundation. The president has been authorized by the council of the academy to appoint five committees in charge of exhibition, meetings, funds, history and membership.

AT the close of the Nineteenth International Congress of Americanists, held in Washington, December 27–31, 1915, a formal invitation was accepted from Brazil to hold the next American Congress at Rio de Janeiro in June of 1918. The invitation was extended through Dr. A. C. Simoens da Silva, by the National Museum, National Library, National Archive, the Brazilian Historical and Geographical Institute and the Society of Geography, at Rio de Janeiro, and the Historical and Geogiaphical Institute Fluminense.

AT the tenth annual meeting of the Entomological Society of America, held at Columbus, Ohio, December 29 and 30, the following officers were elected: *President,* F. M. Webster, U. S. Bureau of Entomology; *First Vice-president,* E. P. Felt, New York State Entomologist; *Second Vice-president,* A. L. Melander, Washington State College; *Secretary-Treasurer,* J. M. Aldrich, U. S. Bureau of Entomology, West LaFayette, Indiana; *Additional Members of the Executive Committee,* H. T. Fernald, Massachusetts Agricultural College; W. E. Britton, state entomologist of Connecticut; P. J. Parrott, entomologist, New York Agricultural Experiment Station; E. D. Ball, Oregon Agricultural College; C. Gordon Hewitt, Dominion entomologist.

THE Florida Entomological Society has recently been organized at Gainesville, Florida, with fifteen charter members. The first officers elected were Professor J. R. Watson, entomologist of the Florida Experiment Station, *President;* Mr. Wilmon Newell, plant commissioner of Florida Plant Board, *Vice-president,* and Mr. R. N. Wilson, U. S. Bureau of Entomology, *Secretary-Treasurer.* A paper was read on the Velvet Bean Caterpillar (*Anticarsia gemmatilis*), by Professor Watson, and another by Dr. E. W. Berger, entomologist of the Florida Plant Board, on the fungus diseases of scales and white flies on citrus.

AT the annual meeting of the Brooklyn Entomological Society, held on the thirteenth inst., the following officers were elected for 1916: *President,* W. J. Davis; *Vice-president,* W. T. Bather; *Treasurer,* Chris. E. Olsen; *Recording Secretary,* J. R. de la Torre Bueno; *Corresponding Secretary,* R. P. Dow; *Librarian,* A. C. Weeks; *Curator,* Geo. Frank; *Publication Committee,* C. Schaeffer, R. P. Dow and the recording secretary, *ex-officio.*

WHILE the aniline dye, potash and other chemical industries have attracted a great deal of attention since the beginning of the European war, little has been heard about the great impetus the war has given our electrochemical industries. Many electrochemical products such as chlorine and hydrogen, which were a

drug on the market before the war, have become valuable. New electrochemical industries, like that of metallic magnesium, have been started and the whole electrochemical development is of the utmost importance to the American nation. The New York Section of the American Electrochemical Society has therefore arranged a symposium on "Electrochemical War Supplies" which it will hold jointly with the New York sections of the American Chemical Society and the Society of Chemical Industry at the Chemist's Club, 52 East 41st St., New York, Friday evening, February 11. The program will include the following papers:

Lawrence Addicks: "Electrochemical War Supplies."

W. S. Landis: "Air Saltpeter."

E. D. Ardery (U. S. Army): "Hydrogen for Military Purposes."

Albert H. Hooker: "New War Products."

William M. Grosvenor: "Magnesium."

G. Ornstein: "Liquid Chlorine."

Geo. W. Sargent: "Electric Steel."

On December 13, there was installed at the University of Pittsburgh, the Beta chapter of the Sigma Gamma Epsilon, the charter members of the new chapter consisting of Dean H. B. Meller, dean of the school of mines, Professor H. C. Ray, professor of metallurgy, and sixteen undergraduates. The Sigma Gamma Epsilon fraternity was founded at the University of Kansas during the past year, and its membership is confined to teachers of geology, mining, or metallurgy, and students who are specializing in those subjects.

The executive committee of the Association of American Universities held a meeting at the University of Pennsylvania on January 24. There were present the following representatives of five universities: Dr. Thomas McBride, president of the State University of Iowa, the president of the association; President Frank J. Goodnow, of Johns Hopkins University, vice-president of the association; President William A. Bryan, of Indiana University; President A. Ross Hill, of the University of Missouri. The University of Pennsylvania was represented by Provost Edgar F. Smith and Dean Herman V. Ames, the University of Pennsylvania, being secretary of the association. The chief business before the committee was to arrange the next annual meeting of the association, which it was voted should be held next fall at Clark University, Worcester, Mass. The following topics were selected for discussion at that time: "How Can Universities be Organized so as to Stimulate work for the Advancement of Science"; "Military Training in Universities and Colleges"; "The Correlation of Work for Higher Degrees in the Graduate School and in Professional Schools."

For ten weeks during the summer of 1916 a party of students and professors from the department of forestry of the New York State College of Agriculture at Cornell University will be in camp on the forest tract belonging to Mr. T. C. Luther at the south end of Saratoga Lake. Last year the Cornell forestry department was in camp on a forest tract in the Northern Adirondacks, on which an estimate of the standing timber was made and a general plan for management was drawn up. A similar study will be made on Mr. Luther's tract, except that in 1916, owing to the proximity of this tract to numerous wood-using mills, greater attention can be paid to the problems of forest utilization.

UNIVERSITY AND EDUCATIONAL NEWS

A "Plan for the Development of the University of California Medical School" has been formally adopted by the regents of the University of California, as a policy to be worked toward. The University of California has now increased to a total of $162,221 per annum its expenditures on medical instruction, over and above the hospital receipts, and within the next few months it will complete the erection, at a cost of $615,000, of a new 216-bed teaching hospital. The regents have now outlined as the immediate future needs of the medical school, a new laboratory build- for anatomy and pathology, to cost $150,000; an "out-patient" building in conjunction with the new teaching hospital, to cost $100,-

000; a nurses' home for 100 nurses, to cost $100,000; and alterations of the existing buildings on the Parnassus Avenue site in San Francisco to accommodate the departments of physiology and physiological chemistry, administrative offices and the medical library.

EDWARD PLAUT, of the class of 1912, has presented $5,000 to Princeton University to establish the Albert Plaut Memorial Library of Chemistry, in memory of his father.

MR. CHRISTOPHER WELCH has left his real estate in the county of Somerset to the University of Oxford for the endowment of scholarships for the study of biology, to be known as the "Welch" scholarships. They are to be tenable for four years and their value is to be £400 a year, any surplus income to be paid into a reserve fund formed by the residue of his estate, to be used for the upkeep of the estate and for furthering the study of biology. If the university does not accept the conditions attached to the bequests then the amount goes to six London hospitals, one of which shall be St. George's Hospital; but no hospital where vivisection is disallowed or discountenanced is to benefit, "antivisectionists being enemies of the human race."

SIR ALEXANDER M'ROBERT has given to Aberdeen University an endowment of about £750 per annum for a Georgina M'Robert lectureship on pathology, with special reference to malignant diseases. The donor recently gave an endowment of £373 per annum to the Aberdeen Royal Infirmary. He is director of the Cawnpore Woollen Mills Company, but before going to India thirty years ago he was Neil Arnott lecturer in experimental physics at the Aberdeen Mechanics' Institution and lecturer in chemistry at Robert Gordon's College, Aberdeen.

THE one hundred and fiftieth anniversary of the founding of the medical school by John Morgan at the University of Pennsylvania will be celebrated by a dinner to be given by the Society of the Alumni of the Medical School at the Bellevue Stratford on the evening of February 4. The committee expects to make this event the largest gathering of its kind ever held by the medical alumni, since it also marks the celebration of the beginning of medical teaching in the United States.

MR. R. M. RAYMOND, managing director of the El Oro Company, has been appointed professor of mining in the School of Mines of Columbia University, succeeding Professor Henry S. Munroe, who retired last June after twenty-seven years of service.

DR. CLARENCE W. FARRAR, of the State Hospital for the Insane, Trenton, has been appointed lecturer on abnormal psychology in Princeton University.

DISCUSSION AND CORRESPONDENCE

FIREFLIES FLASHING IN UNISON

FIFTY years ago in Gorham, Maine, while walking along the road I passed an open field and noticed to my astonishment hundreds of fireflies flashing in perfect unison. I watched this curious sight for some time and the synchronism of the flashing was unbroken. Many times after I have watched these luminous insects, hoping to see a repetition of this phenomenon, but the flashes in every instance were intermittent. Since that time I have read about these insects in various books without meeting any allusion to this peculiar behavior. At last I have found a confirmation of my early observations. In *Nature* of December 9, page 414, is the report of an interesting paper read before the South London Entomological and Natural History Society by K. G. Blair entitled "Luminous Insects" in which reference is made to the remarkable synchronism of the flashes in certain European species of fireflies. The explanation offered as to the cause of this behavior seemed to me inadequate. One often notices in the stridulation of the Grillidæ the perfect time the insects keep in their concerts and it seems likely that the same impulse must animate these flashing beetles, and the light emitted could be more easily followed than the sound.

The following is an extract from Mr. Blair's paper:

Apart from its principal function in securing the proper mating of the sexes, the light seems

also to be largely used, at any rate by the males, for purposes of display. Where the powers of luminosity are largely developed in this sex the emission of the light is usually of an intermittent flashing type. It has been noticed in various parts of the world that these flashing males tend to congregate in large companies, and that all the individuals of one of these gatherings will flash in concert. All the fireflies around one tree or group of trees, for instance, will flash together, while those around a neighboring tree will be pulsating to a different time. This feature has been observed of a European species of *Luciola* (though Mr. Main and myself were unable to detect anything of the sort with *L. italica* at Lugano), of an Indian lampyrid genus not stated, and of the genus *Aspidosoma* in South America. The American species of *Photinus* and *Photuris* do not seem to possess the habit.

The exact reason of this flashing in concert, or the method by which it is brought about, have not been ascertained. It has been suggested that the light is not really intermittent in character, but merely appears so owing to its being alternately masked and exhibited by movements of the creature's body, and that a slight puff of wind might perhaps affect all the members of a company and cause them all to conceal their lights at once. Though this explanation of the intermittent character of the light applies well enough to *Pyrophorus*, an insect we shall shortly consider, it is certainly not applicable to these Lampyridæ. It is true the light is not absolutely extinguished between the flashes, but it is so diminished as to become practically dark; moreover the flashing in unison is too regular to be caused by chance puffs of wind. A more probable explanation of the phenomenon is that each flash exhausts the battery, as it were, and a period of recuperation is required before another flash can be emitted. It is then conceivable that the flash of a leader might act as a stimulus to the discharge of their flashes by the other members of the group, and so bring about the flashing concert by the whole company.

Edward S. Morse

POLYRADIATE CESTODES

In the last number of the *Journal of Parasitology*, Vol. 2, No. 1, p. 7, W. D. Foster, of the Bureau of Animal Industry, U. S. Department of Agriculture, gives an interesting summary of the cases of polyradiate cestodes and describes an adult triradiate cestode of the species *Tænia pisiformis* "found in a mass of tapeworms expelled by an imported collie dog." He states that "no case of an adult triradiate cestode of this species has yet been published." It is to be regretted that Foster did not investigate more thoroughly the literature on the polyradiate cestodes before publishing his article.

In Science, 1910, N. S., Vol. 31, p. 837, in an article "Some New Cases of Trihedral Tænia," we published a brief description of two new species of polyradiate cestodes based on the study of four perfect and entire specimens of *Tænia serrata* = *Tænia pisiformis* and three perfect specimens of *Tænia serialis* which were secured from four dogs picked up on the streets of Lincoln.

Foster bases his description on a "number of chains of triradiate proglottids, the longest piece being 23 cm. representing the anterior half of the worm, except the head." From the study of our specimens we question the validity of a specific diagnosis of *Tænia pisiformis* from proglottids alone, without verification from the scolex.

He states that "the identification of the species was verified by feeding experiments on a rabbit" and that "although shipped in a solution of formalin of unknown strength, and kept in a 2 per cent. solution of formalin for one week after it was received, it was determined to use some of the material for feeding experiments." Foster states that he recovered seven "perfectly normal larvæ" of *Tænia pisiformis* from the omentum and body cavity of a rabbit reared and kept in captivity, thirteen months after feeding with two of the proglottids of the triradiate *Tænia pisiformis* which had been preserved and kept in formalin. It seems to us that the reliability of the results of these feeding experiments is open to serious question, first in the use of material preserved in formalin of uncertain strength and kept in a 2 per cent. solution for one week after it was received and second in the uncertainty as to the previous natural infection of the rabbit used, for we have repeatedly found our rabbits, born and reared in captivity, heavily infected with *Cysticercus pisiformis*.

Foster failed to read and consequently does not cite along with the other theories advanced as to the origin of the polyradiate cestodes, the theory offered by us in the article previously cited, namely that the polyradiate cestodes do not represent distinct species or genera which necessarily originate from and in turn give rise to onchospheres with supernumerary hooks and cysticerci with an excessive number of suckers but may arise from double embryos produced by the partial *separation* of early blastomeres and not by the *fusion* of normal embryos.

In the light of a large amount of data both in the case of natural and experimentally produced twin embryos and adults of a large number of animals which shows that the individuals may be joined in various ways and degrees, our theory as to the origin of the polyradiate cestodes seems the most logical of those offered.

FRANKLIN D. BARKER
THE UNIVERSITY OF NEBRASKA

AN ORGANIC OOLITE FROM THE ORDOVICIAN

MICROSCOPIC examination of a siliceous oolite from the so-called transition bed between the Prairie du Chien dolomite and St. Croix sandstone at McGregor, Iowa, shows the oolite grains to possess undoubted organic structures of the algal type. The matrix of the oolite grains is dolomitic, and many of the original grains themselves have been partly or wholly changed to dolomite with obliteration of structure, prior to silification.

The grains range from .1 mm. to 1.13 mm. in diameter, and, when well preserved, show good concentric and radial structure in addition to the minute sinuous fibers similar to those which characterize the *Girvanella* type of calcareous algæ. These fibers have an average diameter of about .015 mm. Typically the well-preserved grains consist of an inner structureless nucleus, followed by an intermediate band showing radial structure, and this again by an outer band bearing the sinuous fibers. In some instances, however, the two outer bands grade gradually into each other without any distinct line of demarcation.

In view of the present controversy regarding the origin of oolite, it is believed that this occurrence merits more than passing notice.

FRANCIS M. VAN TUYL
UNIVERSITY OF ILLINOIS

USE OF C.G.S. UNITS

IN SCIENCE of December 24, page 904, Professor Kent has been good enough to review the various points raised in the discussion concerning the fundamental equation of dynamics. As space is limited and the discussion has been prolonged, the pedagogic difficulty in the definition of the dyne may be passed over for the present. Whether there is real difficulty in expressing certain derived units because of the use of exponents is open to argument. The cent is a serviceable unit notwithstanding that some financial transactions run up to the millions.

Of more importance however is Professor Kent's statement:

> Of course it is not difficult for *one* who is engaged constantly in the use of the C.G.S. system and who during that year has had no occasion to use the old units, to break away from them, but it is not only difficult but impossible, for a hundred million people who are constantly using the old units to break away from them.

Has he not here overlooked the fact that of the three fundamental units, centimeter, gram and second, one at least, the unit of time, *is* constantly used by more than a hundred million people; and of the three concepts, it is perhaps the most difficult. Are not most scientific men to-day in all countries using C.G.S. units and their derivatives? Is not the kilometer more widely used than the mile; and has not the kilogram come into very general use?

ALEXANDER MCADIE

THE FIRST SECRETARY OF AGRICULTURE

TO THE EDITOR OF SCIENCE: I wish to correct a misstatement which occurred in my article on "Botany in Relation to American Agriculture," published in SCIENCE, January 7. In this article I stated that J. M. Rusk was the

first secretary of agriculture in the President's cabinet. I based this statement upon the fact that the yearbook of the Department of Agriculture for 1888 contained the last report of N. J. Colman as commissioner of agriculture, and the yearbook of 1889, the first report of J. M. Rusk as secretary of agriculture. In his report Rusk states:

> I have the honor to respectfully submit my first annual report as secretary of agriculture, and the first report issued under the newly constituted Department of Agriculture. I assumed the duties of my office March 7, 1889, or twenty-six days after the approval of the law creating an executive department of what had heretofore been a bureau, in executive sense, of the government.

As no mention was made in either report of Colman having acted as secretary of agriculture during this short interval, I took it for granted that Rusk was the first secretary. I have received a letter from Dr. L. O. Howard, however, in which he states that Colman was really the first secretary of agriculture. He writes:

> Mr. Colman was commissioner of agriculture when the bill passed, and was appointed first secretary by President Cleveland on February 13, 1889, his services terminating with the outgoing of the administration on March 6, 1889.

G. P. Clinton

SCIENTIFIC BOOKS

Quantitative Laws in Biological Chemistry. By Svante Arrhenius. London, G. Bell and Sons, Ltd. 160 pp. 6 s. net.

The present volume is a restatement of the grounds upon which the illustrious author of the electrolytic dissociation theory arrived at the conviction that "biological chemistry can not develop into a real science without the aid of the exact methods offered by physical chemistry." It comprises a short résumé, developed with a remarkable degree of clarity and simplicity, of the author's work in the quantitative field of bio-chemistry, together with the investigations of others on neighboring ground. Originally, the material was compiled for the Tyndall lectures given in the Royal Institution in 1914, and is now offered to the public in the hope that it will evoke interest for the new discipline and stimulate new work.

A perusal of the volume, which deals mainly with the velocity of biochemical reactions, the influence of the several factors which govern such velocities and the position of equilibrium can not fail to impress the reader with certain facts. The fundamental import of a knowledge of physical, or rather theoretical, chemistry to the medical student of the future is readily grasped from these pages. The descriptive side of chemical science will more and more be found to be inadequate as a training for the complicated phenomena which the medical student will subsequently face. The volume shows that a real comprehension of the notions of experimental error, probable error and the like will open up to the student new and immense fields for research and for advance.

What is the chief task in that advance? It is to see how far the physico-chemical laws regarding the process of chemical reaction are applicable to biochemical processes and, what is much more important, to attempt to elucidate such processes as have been considered exceptions from known chemical laws. The yield which such an attempt will give is amply illustrated in the present work. It is hard to conceive an ungenerous attitude to a method which has elucidated so many organic processes. The well-known rule of Schutz is a case in point. It is shown that the deviation from the common monomolecular law is readily explainable on the basis of the influence of one of the reaction products on the course of the reaction. Further, the general law for such phenomena is as readily obtained and can be experimentally verified. The more complex phenomena of digestion, secretion and resorption in an animal's body may be shown, as the researches of Pawlow and his co-workers have established, to consist of a number of very simple regularities operating "in vivo" just as "in vitro" and extraordinarily independent of psychical effects and other factors which might lead to the belief that a quantitative study of such phenomena was impossible. As regards chemical equilibria mani-

fested in biochemical processes one can not refrain from contrasting, with Arrhenius, the explanation of the Ehrlich phenomenon on the basis of the law of mass action and that based on the assumption of multitudinous "partial poisons," toxins and toxoids, forming a characteristic if somewhat unintelligible "poison spectrum."

The book should operate as a stimulus and a spur. From personal contact the writer has reaped no small benefit and much inspiration in other branches of the scientific field. Could this volume attract the attention of some young student in the field of biochemical labors and induce in him the determination to go to the source and obtain personally the fruits of ripened thought and mature judgment progress would surely result. In the present pages there is manifest the characteristic genius of the author with his clarity of presentation of the particular thesis in hand. A few infelicities of English occasionally mar the text and suggest that perhaps the assistance of the English editor might have been a little more generously given. Words such as "inanimated" and "stomachical" might readily have been replaced.

HUGH S. TAYLOR

PRINCETON, N. J.

The Physiology of the Amino Acids. By FRANK P. UNDERHILL, Ph.D. Yale University Press. 1915. Pp. 169. Price $1.35.

It is truly symptomatic of modern scientific development that books should be written which divide physiology into physical and chemical portions, and that following this classification still finer divisions are introduced. One of these latter subdivisions is treated for the first time as an entity in Underhill's delightful little book, "The Physiology of the Amino Acids." Each known amino acid is enumerated and its discoverer given. Then follow those details which have thus far been unravelled regarding the intimate life history within the organism of the behavior of the structural units which compose the protein molecule. From the descriptions given in this book the reader may readily grasp the processes of synthesis and analysis, of oxidation and of reduction through the interplay of which protein under given conditions may be resolved into carbonic acid and urea, and under other conditions, into the texture of the living cells. For emphasis of the latter destiny Osborne and Mendel's experiments on the growth of rats form a fitting descriptive material. The book will be of interest and value to biologists in general and to physicians who have not forgotten their chemistry.

GRAHAM LUSK

SPECIAL ARTICLES

THE DISCOVERY OF THE CHESTNUT-BLIGHT PARASITE (ENDOTHIA PARASITICA) AND OTHER CHESTNUT FUNGI IN JAPAN

To Mr. Frank N. Meyer, agricultural explorer of the office of foreign seed and plant introduction of the Department of Agriculture, belongs the distinction of having discovered the chestnut-blight fungus (*Endothia parasitica*) in Japan as well as in China.[1, 2]

Meyer's discovery of the fungus in China has been accepted as proof of the oriental origin of this parasite which has proven so destructive to the chestnut in the northeastern United States and is rapidly spreading southward. Its discovery in Japan furnishes additional evidence as to the correctness of Metcalf's[3] hypothesis that the parasite was introduced into this country from Japan.

Meyer's discovery of *Endothia parasitica* in China made the presence of the same fungus in Japan seem extremely probable. And later, during her visit to this country in the fall of 1914, Dr. Johanna Westerdijk informed the writers that while in Japan she had seen at

[1] Fairchild, David, "The Discovery of the Chestnut-bark Disease in China," SCIENCE, N. S., Vol. 38, No. 974, pp. 297–299, August 29, 1913.

[2] Shear, C. L., and Stevens, Neil E., "The Chestnut-blight Parasite (*Endothia parasitica*) from China," SCIENCE, N. S., Vol. 38, No. 974, pp. 295–297, August 29, 1913.

[3] Metcalf, Haven, "The Immunity of the Japanese Chestnut to the Bark Disease," Bur. Plant Ind., U. S. Dept. Agr. Bull. 121, Pt. 6, 1908.

Nikko and other places chestnut trees affected by a fungus which appeared identical with *Endothia parasitica* in this country. Miss Westerdijk also stated that she had collected specimens of the fungus but these specimens with many of her other collections were lost at sea.

Following this the writers endeavored to obtain specimens of the chestnut-blight parasite by correspondence. Among those to whom the request was sent was Mr. H. Loomis, of Yokohama, who very kindly interested himself in the matter, and on February 18 wrote as follows:

> In compliance with your request of January 4 I have communicated with Professor Y. Kozai, of the Imperial Agricultural Station, Nishigahara, Tokyo, and he writes that "The chestnut blight is found to some extent in the Provinces of Tamba, Ise, Suruga and Shimotsuke (Nikko is in the latter). This disease is limited to the seedlings in the nursery and the young trees (three or four years old) in the field and may be prevented by spraying with Bordeaux mixture."
>
> I have requested him to procure specimens of the fungus and send the same to you directly. I hope this will meet your desire. . . .

Soon after this a packet of three specimens of fungi on chestnut bark was received from Professor Y. Kozai with a letter stating that they were "specimens of the Japanese chestnut canker." None of these proved to be *Endothia parasitica*, but one specimen collected October 14, 1915, in the province of Totomi by S. Tsuruta, and labeled "Cancer on chestnut," was evidently an *Endothia*, which after careful study of stromata, pycnospores and cultures on various media the writers are convinced is identical with the oval-spored species of *Endothia* found both in this country and in Europe and referred to in their earlier paper[4] as *Endothia radicalis* (Schw.) De Not. The other two specimens sent by Professor Kozai showed no *Endothia* but two other Pyrenomycetes.

[4] Shear, C. L., and Stevens, Neil E., "Cultural Characters of the Chestnut-blight Fungus and Its Near Relatives," Circ. No. 131, B. P. I., Dept. Agr., July 5, 1913.

Shortly before the specimens above referred to were received from Japan a number of specimens of Japanese chestnut from California were turned over to the writers for study. These were part of a shipment from the Yokohama Nursery Co., Yokohama, Japan, consigned to the Sunset Nursery, Oakland, Cal., which were condemned in February, 1915, by Frederick Maskew, chief deputy quarantine officer, San Francisco, Cal., upon recommendation of Dr. E. P. Meinecke, forest pathologist, U. S. Department of Agriculture, stationed in that city. In his letter recommending the destruction of this nursery stock Dr. Meinecke called attention to the presence of a fungus apparently parasitic which "in the absence of other fruiting forms must be classed with the fungi imperfecti (*Cytospora* species.)" Of 100 plants examined Dr. Meinecke found 43 infected with this fungus. A number of the infected trees were turned over to the writers by the Federal Horticultural Board and bear their plant disease survey number 264.

The writers have had the fungus referred to by Dr. Meinecke in culture since early in April, 1915, and have made inoculations on the native American chestnut (*Castanea dentata*) but thus far have been unable to obtain ascospores or any evidence of parasitism on *Castanea dentata*.

In addition to this fungus two of the Japanese seedlings received from California showed a few tiny, yellow ochre pycnidial stromata, smaller than but closely resembling in form and color those of *Endothia radicalis*. A careful study of the pycnidia, pycnospores and cultures of this fungus on various media has convinced the writers that this also is a species of *Endothia* having quite different cultural characters from any species yet known.

Mr. Walter T. Swingle during his recent visit to Japan obtained a small portion of a specimen which was exhibited as chestnut-blight. This specimen which was given him by Dr. Nishida is not an *Endothia*, but so far as can be determined from cultures appears to be identical with the imperfect fungus found on the Japanese chestnuts condemned at San Francisco in February, 1915.

From a study of these few specimens it is evident that there are in Japan several Pyrenomycetes including species of *Endothia* more or less parasitic on chestnut. This fact may help to explain the failure of Japanese pathologists to distinguish the true chestnut blight caused by *Endothia parasitica*. Dr. Gentaro Yamada on his recent visit, July, 1915, to this country, informed the writers that the numerous publications concerning the chestnut-blight in the United States had naturally aroused the interests of Japanese pathologists but that so far they had been unable to find any parasitic *Endothia*. This is further verified by a paper in Japanese[5] by Kanesuke Hara, an abstract of which has been kindly furnished us by Dr. T. Tanaka. Hara considers that *Endothia gyrosa* (Schw.) Fuck. must be identical with *E. parasitica* (Murr.) A. & A. He describes a species of *Endothia* found on a dead twig of *Quercus glandulifera* Bl., which he regards as *Endothia gyrosa*. This report indicates that species of *Endothia* occur in Japan upon *Quercus* as well as on *Castanea*. We have just received pycnidia of an *Endothia* on chestnut from Mt. Hara labelled *E. gyroza?* which in culture appears different from any species yet cultured by the writers.

Having failed to obtain a specimen of *Endothia parasitica* by correspondence and learning that Mr. Meyer was to visit Japan on his return from China, the writers requested Mr. David Fairchild, agricultural explorer in charge of foreign seed and plant introduction, to send a cablegram asking him to look for the chestnut blight in the vicinity of Nikko. Meyer's observations in Japan are best given by quotations from his letters:

> Sept. 17. Frid. In Nikko . . . found plenty of evidences of the chestnut-blight, especially on the higher, more exposed parts of the mountains; collected a large bundle of material, took several fotos. . . .[6]

> Sund. Sept. 19. In Yokohama; . . . inspected grafted and budded nursery stock, especially chestnuts and cherries, found them exceptionally clean. No signs of *Diaporthe parasitica* on chestnut seedling and grafted stock, although the wild trees of *Castanea japonica* on the hills surrounding the nurseries are infested with the blight.

> Mond. Sept. 20. In Yokohama; . . . The chestnut-blight, *Diaporthe parasitica*, is quite common in Japan, that is at least around Nikko, Tokyo and Yokohama. Wild as well as cultivated trees are attacked, though the disease, as a whole, is not very destructive. Trees vary considerably as regards powers of resistancy and on the lower slopes of hills around the Kanaya Hotel at Nikko, trees were found that were large and vigorous and apparently immune, while on the higher mountains and more exposed parts trees were found that were badly attacked. This Japanese chestnut, *Castanea japonica* might be used as a factor in hybridization experiments, together with American, European and Chinese species to create immune or nearly immune strains of chestnuts.

Meyer further states to the writers that the Japanese chestnut, *Castanea crenata* Sieb. & Zucc., is even more resistant to *Endothia parasitica* than is the Chinese chestnut, *Castanea mollissima*. This further emphasizes the difficulty of locating *E. parasitica* on chestnut in Japan where as already stated several other fungi are common.

On the arrival of Meyer in Washington he gave the writers specimens of diseased chestnut branches collected at Yokohama and at Nikko. On the material from Yokohama no *Endothia* was found. Specimens from Nikko which were more abundant showed cankers and mycelial fans typical of *Endothia parasitica* and numerous stromata of the fungus. Some of these stromata contained mature ascospores and many of them viable pycnospores and ascospores. Cultures were at once made on cornmeal in flasks and on cornmeal and potato agar. These cultures proved identical with cultures made at the same time from typical *E. parasitica* collected in this country and also with the Chinese material which has been kept in pure culture. While the season of the year makes inoculations impossible the mycelial and spore characters of this fungus

[5] Hara, Kanesuke, "Further Discussion Must be Needed on the Problem of the Chestnut-blight Disease, 'Byôchû-gai Zassi'" (*Journal of Plant Protection*), Vol. 2, No. 3, March, 1915, pp. 242–245 (Japanese).

[6] Some of the pictures of blighted chestnuts taken by Meyer at Nikko will be published later.

as well as its cultural characters are so distinctive as to leave no doubt as to its identity. The fungus collected by Meyer at Nikko is unquestionably *Endothia parasitica*.

The above statement was completed and submitted for publication December 23, 1915. During the interval following, several specimens of fungi from Japan have been received by the writers which are of such interest in connection with the observations recorded above that it seems desirable to add them. On December 27, 1915, there was received from the Federal Horticultural Board a specimen of diseased chestnut nursery stock (their number 947), which had been sent by H. M. Williamson, secretary of the State Board of Horticulture at Portland, Oregon.

In the letter transmitting the specimen Mr. Williamson states that it was from

> an importation of nursery stock . . . grown at Kanagawa-Ken, Yokohama, Japan. . . . Included in this shipment were some chestnut trees and five of the chestnut trees were diseased. . . . Four of the chestnut trees have been burned and I am mailing you the other diseased tree under separate cover.

The fungus, which showed only pycnidia, has been cultured and is apparently the same as that found on the chestnut seedlings condemned at San Francisco in February, 1915, and mentioned above, and which was also found on the specimen brought from Japan by Swingle.

A small specimen of an *Endothia* collected at Nikko, Japan, September 17, 1915, on bark of *Pasania* sp. (*Quercus* of some authors), has been recently transmitted to the writers by Mr. Frank N. Meyer. This specimen shows typical ascospores of *Endothia radicalis* (Schw.) and in cultures proved identical with those of *Endothia radicalis* collected in this country. This collection seems to leave no doubt that *E. radicalis* is indigenous in Japan and that there as in Europe and America it is not confined to *Castanea*.

January 8, 1916, the writers received from Dr. Gentaro Yamada, of the Morioka Imperial College of Agriculture and Forestry, two specimens, one labeled "on *Quercus crispula*. Mt. Moriva, near Sapporo, Hokkaido, Japan. March 27, 1897. Coll. G. Yamada & T. Totsu," the other labeled "*Endothia parasitica* on *Castanea vulgaris* Lam. var. japonica DC. Morioka, northern Japan. Dec. 5, 1915. Coll. G. Yamada." The fungus on *Quercus crispula* was of course no longer viable. It contained, however, abundant ascospores which agree in their measurements with those of *Endothia radicalis*.

The specimen on *Castanea* is typical *Endothia parasitica*, as shown by the mycelial fans, pycnospores and ascospores, and by cultures. This specimen shows hypertrophy of the tissues very similar to that produced by the fungus on American chestnuts. In the letter accompanying this specimen, dated December 15, 1915, Dr. Yamada says he found the specimen of *E. parasitica* on his first collecting trip after his return to Japan. In this connection it may be stated that during his recent visit to this country Dr. Yamada spent some time with the writers in examining specimens of *Endothia parasitica* and other species of *Endothia* and took back with him typical specimens. This probably accounts for his finding the fungus so quickly.

C. L. Shear,
Neil E. Stevens
Bureau of Plant Industry,
Washington, D. C.

THE AMERICAN SOCIETY OF ZOOLOGISTS. II

GENETICS

Sex Controlled in Rotifers by Food (illustrated by lantern): D. D. Whitney, Wesleyan University.

Several species from two of the five orders of rotifers have yielded very positive results. All female offspring were produced under certain food conditions and from 30 per cent. to 95 per cent. male offspring were produced under certain other food conditions. In some of the species the offspring were all females when the race was fed upon a diet of colorless flagellates, but when the race was suddenly put upon a diet of green flagellates a high percentage of male offspring appeared. In other species a scanty diet of green flagellates produced all female offspring while a

copious diet of the same green flagellates produced as high as 95 per cent. of male offspring, thus showing that it is the quantity of the food that regulates the production of the sexes and not the stimulus of a change of food.

Male-production in Hydatina Favored by Oxygen: A. FRANKLIN SHULL AND SONIA LADOFF, University of Michigan.

Whitney's experiments of a year ago, in which feeding these rotifers on the green flagellate *Chlamydomonas* resulted in greatly increased male-production, left room for doubt whether other agents than nutrition might not be producing part of the effects noted. The food cultures were differently constituted at the outset, and the organisms reared in them may have produced secondary differences. We have attempted to test some of the possible factors other than nutrition. So far our results may be interpreted largely in support of Whitney's conclusion; for, while one of the suspected agents has been found to increase male-production, its effect is not so marked as that in Whitney's experiments. The one effective factor discovered is oxygen. Under several different conditions, oxygen produced uniform effects of moderate degree.

On the Inheritance of Size in Paramecium: JAMES E. ACKERT, Kansas State Agricultural College.

A series of experiments with *Paramecium caudatum* and *P. aurelia* was carried on with a view to determining the effect of selection within the progeny of a single individual. In 1911, when these experiments were begun, the excellent work of Jennings had already been reported; but, to test this principle, independently, using large numbers of individuals, seemed justifiable. In a typical experiment a single *Paramecium* was isolated on a depression slide in a few drops of hay infusion. After several generations there were isolated from its descendants two *Paramecia*—one, the shortest of the progeny, the other, the longest. The descendants of each of these individuals were kept in separate receptacles under environmental conditions as nearly identical as possible. At a later time all but a few of the animals of each group were killed and measured. In all of the experiments, except one, the images of the *Paramecia* were thrown upon a screen with a combination microscope and lantern, giving a magnification of 3,200 diameters. The usual methods of dealing with statistical data were used in the preparation of the results. In all cases the effect of the selection within the progeny of a single individual was negative. In some instances the difference in mean lengths of the groups under comparison fell within the probable errors of the means; in others the mean lengths of the progeny of the smaller *Paramecia* were larger than those of the descendants of the larger *Paramecia*. The conclusion is based upon measurements of nearly 6,000 *Paramecia*.

The Influence of Selection on the Number of Extra Bristles in Drosophila: E. CARLETON MACDOWELL, Carnegie Institution of Washington.

Previously it has been shown that the extra bristles that characterize a certain race of *Drosophila* are conditioned by a Mendelian determiner; that the exact number of extra bristles is not inherited, but varies in relation to external conditions; that, in spite of this, the selection of high variates as parents, continuously raised the averages of the race for several generations, after which no further progress could be determined. The present report carries the selection for increased numbers of bristles to the forty-sixth generation. In certain of the later generations the averages have been raised by more favorable conditions and by counting only the large flies that hatch at the first of a bottle, the flies at the end of a bottle being smaller and with fewer bristles. The upper limits of the distributions would not be influenced in the same way, and so offer a better test for the effect of selection. These upper limits show no tendency to advance after the first few generations. Two series of return selections have been made, from the sixteenth and twenty-seventh generations. These failed to show any lowering of the averages, although carried on for six and eight generations, whereas the initial rise of the averages was immediate. The distribution of extra bristles extracted from a cross with normals is lower than that of the corresponding inbred generation. A race of low grade has been established from extras extracted from a cross. This race averages about two bristles lower than the high-selected race. If, as formerly proposed, the initial rise in the averages was due to a sifting out of secondary determiners, all the above results would be expected.

Twinning in Cattle, with Special Reference to the Free Martin (illustrated with lantern): LEON J. COLE, College of Agriculture of Wisconsin.

A study of 303 multiple births in cattle, obtained directly from breeders. The records include: 43 cases homosexual male, 165 cases recorded heterosexual (male and female), 88 cases

homosexual female, 7 cases triplets, a ratio of twins of approximately 1:4:2 instead of the 1:2:1 expected if there were no disturbing element entering in. The expectation may be brought more nearly into harmony with the facts if it is assumed that in addition to ordinary fraternal (dizygotic) twins there are numbers of "identical" (monozygotic) twins of both sexes, and that while in the case of females these are both normal, in the case of a dividing male zygote, to form two individuals, in one of them the sexual organs remain in the undifferentiated stage, so that the animal superficially resembles a female and is ordinarily recorded as such, although it is barren. The records for monozygotic twins accordingly go to increase the homosexual female and the heterosexual classes, while the homosexual male class, in which part of them really belong, does not receive any increment. This brings the expected ratio much nearer the ratio obtained.

Any female calf twinned with a male is referred to as a free martin. According to the interpretation given, some free martins should be fertile, while others are sterile. It was found that both classes exist.

CYTOLOGY

The Mitochondria in the Germ Cells of the Male of Gryllotalpa borealis: F. Payne, Indiana University.

The mitochondria are present in the spermatogonial cells in the form of granules lying at one side of the nucleus and between the nucleus and cell wall. In the early growth-period the granular appearance is replaced by a thread-like arrangement. The threads are grouped into a mass and lie in contact or near the nucleus. They remain in this position and condition throughout the growth-period. In the prophase of the first maturation division the threads come out of the mass and as the spindle forms they take up a position outside the spindle, but extending about half-way round it. The threads are almost as long as the spindle. After the chromosomes have reached the ends of the spindle the elongated mitochondrial threads seem to break near the middle, part of them moving along the spindle toward one pole and part toward the other. The threads seem to be approximately halved. In the second division a similar process takes place. Each spermatid, then, receives a mass of mitochondria. In the transformation of this spermatid into a spermatozoon the mitochondria take part in the formation of the tail, but nothing more.

Pairing of Chromosomes in the Diptera: Chas. W. Metz, Carnegie Institution of Washington. (Introduced by C. B. Davenport.)

A study of the chromosomes in about 75 species of Diptera, ranging from among the lowest to the highest in the order, reveals the following facts:

First, a paired association of chromosomes is found to exist as a normal condition in all species studied.

Second, the two members of each pair of chromosomes are homologous elements, of respectively maternal and paternal derivation.

Third, the association of homologous chromosomes into pairs occurs at a very early stage in ontogeny (before cleavage is completed) and persists throughout the larval, pupal and adult life of the fly.

Fourth, the paired association is found in all diploid cells, somatic as well as germinal.

Fifth, it apparently persists throughout all stages in the growth and division of each cell, being evident from earliest prophase to latest anaphase.

Sixth, to account for this side-by-side approximation of homologous chromosomes exhibited by the flies something more than purely mechanical forces must be taken into consideration.

The data indicates that pairing must depend upon the qualitative nature of the chromosomes. From this, and the fact that paired chromosomes are homologous chromosomes, the evidence is seen strongly to support the hypothesis that homologous chromosomes are qualitatively similar and that non-homologous chromosomes are qualitatively different in their make-up, and that therein lies the secret of Mendelian heredity.

Chromosome Individuality in Fish Eggs: A. Richards, University of Texas.

The observation of Miss Morris, that the chromosomes from the two parents can be recognized in *Fundulus* eggs fertilized with *Ctenolobrus* sperm is verified. Furthermore, even in the telophases of cleavage mitoses it is possible to recognize clearly the chromosomal vesicles as separate bodies, and in the resting nuclei the parts contributed by the individual chromosome can be distinguished without difficulty. Treatment of the eggs or sperm before or after fertilization by X-rays serves to emphasize this distinctness.

Studies on the Chromosomes of the Common Fowl (illustrated with lantern slides of photomicrographs): M. F. Guyer, University of Wisconsin.

My later studies, extending over a period of more than ten years, afford abundant confirmatory evidence of my earlier findings that in the spermatogenesis of the common fowl, a large curved chromosome, comparable to the sex-chromosome of other forms, typically passes undivided to one pole of the spindle during the division of the primary spermatocyte. To determine what form this element assumes in the somatic cells of male and female fowls, a study of the cells of embryo chicks was undertaken. In the main chicks of 10, 13 and 20 days of incubation were used. The cells studied were, for the most part, those of the developing nephridial tubules, the nervous system and the gonads. Two fairly well marked curved rods —easily discernible from the other chromosomes— were found to occur with great frequency in the cells of the male. A reexamination of spermatogonia of both the common and the guinea fowl revealed similar paired elements. In the female in a significant percentage of cases only a single element of like appearance could be found. Thus, for this element, the male appears to be homozygous, the female heterozygous. The large curved element of the primary spermatocyte would seem to be in reality, therefore, a double element formed by the fusion of the pair of curved chromosomes which exist independently in somatic and early germ-cells. However, the passing over of this element undivided in the first maturation division brings about a condition of dimorphism in the later male germ cells. An important point to be substantiated yet is whether one class of these degenerate without forming spermatozoa, or, if forming them, whether they are not sterile.

EMBRYOLOGY

Fish Hybridization an Instrument in Morphogenetic Research: H. H. NEWMAN, University of Chicago.

During the past ten years experiments in fish hybridization have engaged a considerable share of my attention and I have been strongly impressed with the possibilities offered by this field of experimentation. Practically any type of morphogenetic disturbance that has been obtained by physical or chemical means is duplicated in some common teleost hybrid. Certain crosses give all of the grades of optic anomaly described by Stockard and others as due to various anesthetics. Double-headed, double- and triple-tailed monsters, etc., are very numerous in some crosses and the genesis of these conditions could be readily studied in living material.

Among the most interesting anomalous conditions seen in these hybrids are the various disturbances in the relations of parts of the vitelline and systemic circulation. The heart and its main vessels frequently appear disjoined from the body, and exhibit an independence in differentiation and an automaticity truly striking. Many problems might be cleared up by a study of these conditions.

The various developmental blocks in hybrid crosses are of considerable general interest, especially to the experimental embryologist. The fact that the end of the cleavage period is the commonest block to hybrid development is significant in the interpretation of the physiology of cleavage and of gastrulation.

Other blocks such as those occurring during gastrulation, especially those involving disturbances of the mechanism of concrescence, are scarcely less significant.

Apart from hybrid results per se the hybridization method itself is of much broader application for experimental biology.

Structure and Function in the Development of the Special Senses in Mammals: H. H. LANE, University of Oklahoma.

By physiological experimentation upon the embryo and fetus of the rat and other mammals at different stages in their development, the time when each of the special senses—touch, equilibrium, taste, smell, hearing and sight—first becomes functional has been determined within relatively small limits of probable error, and a study made of the corresponding structural development. Considering a reflex arc involving any special sense, it has been found that the association centers, the afferent and efferent nerve-trunks, and the effective motor apparatus are all in working order before the special sense organ concerned is capable of functioning, *i. e.*, the organ of special sense is in each case the last link in the chain to be perfected, and in each case the function is established when (and only so soon as) the proper peripheral sense organ has reached its functional state. The order of development of the organs of special sense and their correlated mechanisms is not that demanded by a Lamarckian hypothesis. It seems evident from these investigations (which are being extended) that the development of the nervous system in general and the differentiation of its constituent parts are due not to *epigenesis,* but to *endogenesis,* or predetermination in the oosperm; that these structures appear not as direct responses to the needs of the embryo, but in anticipation of those needs; not under the influence of their spe-

cific, definitive environmental stimuli, but because of the inherited organization and forces in the oosperm, which can only be secondarily modified or controlled by other factors.

The Development of Recurrent Bronchi and of Air Sacs of the Avian Lung: WM. A. LOCY AND OLOF LASSELL, Northwestern University.

The notable observations of Schulze (1911) and of Juillet (1912) have brought forward a newly recognized structural element—the recurrent bronchi—known only in the lungs of birds, which imparts a renewed interest in the structural peculiarities of the avian lung and in the physiology of its air-sacs. The development of these recurrent bronchi, beginning as buds on the air-sacs and growing into the lungs, as illustrated by the lantern slides, and the condition of the recurrent bronchi of the adult lung is shown by Wood's metal casts. The formation of bronchial circuits within the lung by the union of recurrent bronchi with branches of other bronchi is indicated, and the probable physiology of the air-sacs is briefly considered.

Regarding the development of the air-sacs, the interclavicular is shown to arise from four separate moieties, two from each lung, which later unite to form the single median sac of the adult. The lateral moieties of the interclavicular sac have long been recognized, but the existence of separate mesial moieties and the manner of the union of the four parts is believed to be presented for the first time.

COMPARATIVE ANATOMY

The Olfactory Organs of Lepidoptera: N. E. MCINDOO, Bureau of Entomology.

The organs discussed in this paper are the olfactory pores, already described by the writer for the Honey Bee, Hymenoptera and Coleoptera in other papers. The present paper deals with only the morphology of these organs in Lepidoptera.

As usual, the olfactory pores are found on the legs, wings and mouth-parts. Two groups are always present on each trochanter; one group usually on each femur; a few scattered pores generally on each tibia, some of these sometimes being in the tibial spines; one to four groups on the base of each wing, besides scattered pores usually extending the full length of the wing; and a few pores on the mouth-parts.

The total number of olfactory pores varies from about 500 to 1,300. Moths usually have more pores than butterflies. Based on the total number of pores, the individual, sexual and specific differences are slight, while the generic differences may or may not be slight, the latter differences depending on the sizes of the specimens compared.

The olfactory pores are flask-shaped structures, and those on the wings have been called dome-shaped organs because the chitin surrounding each pore aperture is arched dome-like above the general surface of the wing. As usual, chitinous cones are present and the sense cells are spindle-shaped. In distribution and structure the olfactory pores of Lepidoptera are more similar to those of Hymenoptera than to those of Coleoptera.

The Structure of Agelacrinites, a Fossil Echinoderm (Cistoid) of the Richmond (illustrated with lantern): S. R. WILLIAMS, Miami University.

1. Agelacrinites was probably somewhat motile—at least able to adapt its peripheral rim to its surroundings.

2. The peripheral rim may have been extensible.

3. The animal probably breathed by muscular protraction, extension and retraction of the anal pyramid, getting oxygen by rectal respiration.

4. The probable path of the alimentary canal in the young animal.

5. Cover plates and floor plates of the brachial grooves and their patterns.

Neuromeres and Metameres: H. V. NEAL, Tufts College.

The paper summarizes observations upon the nidular relations of cranial nerves in *Squalus* embryos and raises the problem, Are neuromeres reliable criteria of the primitive metamerism of the vertebrate head?

The motor nidulus of the trigeminus lies in the second and third hind brain neuromere (rhombomere); that of the facialis extends through four rhombomeres, viz., the fourth, fifth, sixth and seventh. The nidulus of the glossopharyngeus lies in the sixth and seventh rhombomeres, while that of the vagus extends from the posterior part of the seventh for a considerable distance in the unsegmented portion of the medulla.

Of the somatic motor nerves, the nidulus of the oculomotorius lies in the midbrain; that of the trochlearis lies primarily in the first (cerebellar) rhombomere; that of the abducens extends through the sixth rhombomere and somewhat into the two adjacent ones. The nidulus of the hypoglossus lies in the unsegmented portion of the medulla posterior to the seventh rhombomere.

Somatic motor niduli lie primarily dorso-lateral

to splanchnic motor niduli. Secondarily by migration (neurobiotaxis) these relations are reversed as in mammals (Graeper, '13).

The connection of four rhombomeres with a single visceral arch (the hyoid), and of three visceral arches with a single rhombomere (the seventh) is a fact not easily reconciled with the assumption that a single rhombomere was originally connected by a splanchnic motor nerve with a single visceral arch.

The Spines of Catfishes (illustrated with lantern): H. D. REED AND T. J. LLOYD, Cornell University.

The following observations upon the spines of catfishes were made chiefly upon the pectoral fins of *Ameiurus nebulosus* and various species of *Schilbeodes,* and are incidental to another study. In an attempt to determine the morphology of certain soft parts of the fins of catfishes it became obvious that there existed a definite relation to the morphology of the spines. A search of the literature revealed only such statements as "the spines are believed to represent a fusion of soft rays" rather than the ankylosis of the lepidotrichia of a single soft ray as in the true spiny-rayed fishes.

A study of the mature spines and developmental stages shows that the spines of the catfishes examined represent a fusion of several soft rays. The rays contributing to the formation of spines arise in the typical fashion and the fusion of rays as well as the lepidotrichia is from the base toward the free end. The cavity of the spine represents the distal (cephalic) half of the space found normally between the individuals of the fused pairs of lepidotrichia. The last ray, in young individuals, at least, is free for its distal half where it is segmented and bifurcates, as do the unmodified soft rays.

MISCELLANEOUS

A New Method of Observing the Bronchial Tree of the Embryonic Lung: WM. A. LOCY AND OLOF LASSELL, Northwestern University.

The difficulties of observing early stages of the bronchial tree of the embryonic lung are considerable. Wax reconstructions, celloidin injections and Wood's metal casts have unfavorable limitations.

A simple method is now available by the modification of a method of an injection originated by Hochstetter in 1898, for study of the semicircular canals of the ear. The lungs are dissected out of fixed and hardened specimens and cleared in thick cedar oil, after which they are immersed in a mixture of one part thick cedar oil and two parts chloroform. After thorough penetration, the specimen is removed from the mixture and placed on a filter paper until the chloroform evaporates. This serves to draw the cedar oil from the various branches of the bronchial tree and to fill the spaces with air. When the air-filled preparation is immersed in pure cedar oil the entire bronchial tree presents the appearance of being filled with a bright metallic cast and can be readily observed through the translucent walls of the lung. The minuter air passages are permeated, and, although the smallest ones disappear in a few minutes as the cedar oil percolates into them, the same specimen, if carefully manipulated, can be treated repeatedly without apparent injury. Results of this method are illustrated by lantern slides.

The Parasitic Fauna of the Bermudas: FRANKLIN D. BARKER, University of Nebraska.

The preliminary study of the animal parasites collected in the Bermudas during the summer of 1912 has been completed. A brief summary of the parasites found is as follows:

Parasite	Number of Species Found	Host
1. Protozoa	1	Toad
2. Trematoda		
A. Encysted	2	2 species of fish
B. Ectoparasites	2	9 species of fish
C. Endoparasites	44	23 species of fish
"	2	2 species of sea-cucumber
3. Turbellarias endoparasites		
4. Cestoda		
A. Mature	0	0
B. Immature (free)	2	6 species of fish
C. Immature (encysted)	5	14 species of fish
5. Nematoda		
A. Mature	3	7 species of fish
B. Immature (free)	3	10 species of fish
C. Immature (encysted)	2	5 species of fish
6. Acanthocephala	3	7 species of fish
7. Crustacea		
A. Copepoda	Undetermined	10 species of fish
B. Isopoda	Undetermined	5 species of fish

This study has been intensive for a comparatively small number of individuals rather than a superficial examination of a large number, with the result that the parasites found are all in first-class condition for detailed study. This has made it possible for us to add ten new species of trematodes, two new species of nematodes and one new species of acanthocephala to the large list of helminthes found in the fishes of the Bermudas and the Dry Tortugas by Linton (1908; 1910). We have also been able to add considerably to the meager descriptions of some species as well as to identify a number of Linton's undetermined species.

This and future intensive study of the parasitic fauna of the Bermudas has been made possible through the assistance of the Museum of Comparative Zoology of Harvard University and the Bache Fund of the National Academy of Sciences.

Increase in Opportunities for Work at the Bermuda Biological Station (illustrated with lantern): E. L. Mark, Harvard University.

By a recent agreement between the Bermuda Natural History Society and Harvard University, the Bermuda Biological Station for Research, which has hitherto been in operation for only six or eight weeks each summer, is now to be open throughout the year. Harvard has appointed Dr. William J. Crozier, resident naturalist and Mrs. Crozier, librarian and recorder. Dr. and Mrs. Crozier are living in one of the cottages on Agar's Island, where the station and the Bermuda Public Aquarium are located. The new arrangement will permit the investigation of classes of problems which could not be undertaken during a sojourn of a few weeks in midsummer, and will give opportunity to study seasonal variations as well as the times of fruiting and spawning. Not the least of the advantages resulting from this change is the opportunity it will give biologists to carry on work at a midocean station at any time of the year when they may choose to avail themselves of it.

The laboratory has accommodations for about a dozen investigators. It is not proposed at present to charge any fee for the privileges of the station. The purpose is to provide facilities for persons who are competent to carry on original work, and for such only; no instruction is offered; and the station is not to be used for the purpose of making miscellaneous collections of commercial value. The staff of the station will endeavor to procure and prepare at moderate cost material needed for investigations or for use in teaching.

Having completed the papers listed on the printed program, the following papers, received too late to be printed on the program, with the consent of the society were read:

The Cranial Nerves of an Adult Cœcelian: H. W. Norris, Grinnell College.

Two types: (1) Eye covered by the maxilla, eyeball very rudimentary, no optic nerve, no eye-muscle nerves, except abducens, no eye-muscles; (2) Eye not covered by maxilla, shows characteristic structure with nerves and muscles. Abducens in both innervates the retractor tentaculi muscle.

Lateral line components absent. Olfactory nerve apparently double, but actually merely exaggerating the condition found in other Amphibia. Two ganglia on trigeminal-nerve, as noted by previous writers. General cutaneous component in facial nerve, blending anteriorly with the trigeminal.

Previous writers (Marcus excepted) have represented posterior to the seventh and eighth nerves a complex with very puzzling characteristics. Resolved into its components this complex consists of: a ramus jugularis VII. that extends far back in the body to innervate the sphincter colli muscle; a sympathetic trunk, with two large ganglia, that has its origin in the gasserian and facial ganglia and reaches far beyond the posterior limits of the head; the IX.–X. nerve trunk with two distinct ganglia; an occipital nerve that passes through the posterior part of the first IX.–X. ganglion; the first, second and third spinal nerves, the first of which gives origin to the hypoglossal nerve, the second of which sends a branch through the second sympathetic ganglion, and the third of which sends a branch into the posterior tip of the same ganglion.

The Advancing Pendulum of Biological Thought: C. C. Nutting, State University of Iowa.

The figure of an advancing pendulum correctly represents the course of scientific progress. The alternate swings to right and left culminate in extreme positions, but the net result is a real advance.

The NeoDarwinian swing led by Weismann. Its extreme position and the net gain.

The NeoLamarckian swing led by the "American School." The extreme position of E. D. Cope and the net gain.

The Mendelian swing led by Bateson, Castle and others. The extreme position of Bateson. A biological justification of the theological doctrines of foreordination and regeneration. The net gain.

General principles deduced from this discussion.

The pendulum of thought never retraces its course; but there is regularly a net gain.

The extreme position, or furthest point of each swing, is almost invariably wrong.

Each leader contributes something real to progress, and it is unwise to utterly discredit him. Witness Morgan and pangenesis.

The return from the extreme of the Mendelian swing. Witness Castle and E. B. Wilson.

The position of the systematist under present conditions.

A Case of Sex-Linked Inheritance in Man: HANSFORD MACCURDY, Alma College.

In the history of a certain family in Michigan, there occurs a most interesting case of the transmission of a peculiar character, which manifests itself at the approach of maturity in a certain proportion of the males. It makes its appearance only after a long series of complex physiological processes and in a remote period of development. The factors are evidently not simple, and possibly may manifest themselves in various ways; but the particular character here noted affects the feet of males in a definite proportion.

An affected male does not transmit the factor or factors to his sons. He transmits them through his daughter married to a normal male through four out of five of his granddaughters, and through these to half of their sons.

According to the chromosomal hypothesis of control of development and heredity this is a case of sex-linked inheritance and is limited to one half of the sons of the daughters of affected males. It also indirectly points to the transmission of characters or factors detrimental to one sex.

The Components of the Cerebral Ganglia and Nerves of a 23 mm. Embryo of Squalus Acanthias: F. L. LANDACRE, Ohio State University.

The 23 mm. embryo of *Squallus* was selected because it is sufficiently developed to enable one to recognize the principal nerves and determine their composition while the ganglia are still fairly well separated so that their boundaries can be determined. The chief ganglia and nerves are found to be typical for Ichthyopsida in general. Some of the peculiarities noted are the very small size of oph. sup. V.; the separateness of the lateral lines organ primordia; the large size of the epibrachial placodes; the precocious character of the lateral line nerves as compared with other nerves. The analysis, which can be shown briefly only by means of a diagram, is offered tentatively in the absence of a published analysis of a more mature individual.

Silk Spinning in Its Relation to the Feeding Habits of Chironomus lobiferus Say: ADELBERT L. LEATHERS, Cornell University.

The larvæ of *Chironomus lobiferus* were found inhabiting the air cavities of the living stems of *Sparganium* sp., which they penetrate by boring two small openings through the epidermis. Here they maintain suitable living conditions by a regular undulating motion of the body which sets up a current of water through the burrow. An examination of the stomach contents showed the food to be plankton and not the tissue of the plant. It was found that these larvæ will adapt themselves to living in glass tubes, and under such conditions careful observation revealed a conical net fastened at the base to the silken lining of the larval gallery and held extended by radiating threads attached to its apex. This net is made to bulge out by the pressure of the current forced into it. The smaller particles become tangled in its meshes and the protozoa, diatoms and other unicellular algæ are largely removed, although some escape through gaps near the rim of the net. When this current has been maintained for about ten minutes, regardless of the amount of food in the net at any time, the larva turns about in its burrow and grasps one edge of the net and forces it into its mouth, then rotates its body and grasps another part, and so on until the net is entirely swallowed. Then it spins another, spreading and attaching the silk by its anterior prolegs; turns about and begins the undulating motion again.

The Resistance of Starved and Normal Fishes to Low Oxygen and the Effect upon this Resistance of Acids, Alkalies, Salts, Etc.: MORRIS M. WELLS, University of Chicago.

The resistance of normal fishes to various concentrations and combinations of oxygen and carbon dioxide was determined in 1913 (*Biol. Bull.*, Vol. 25) and since that time an improved apparatus has been devised and the resistance of starved fishes at different periods during the starving process has been determined. The work is being pushed further in an attempt to determine the relation of the oxidations of the fishes to the presence of other substances in the water. The effects of acidity and alkalinity have been compared, the dying time in running and stagnant water has been determined and the work that is now under way contemplates the determining in the next three weeks of the effect upon the resistance of the fishes of the presence of various salts and sugars, and a comparison of the effects of KCN as compared with low oxygen.

Results already obtained:

1. An apparatus that will furnish a flow of about one liter of oxygen-free water per minute.

2. A determination of the seasonal resistance of fresh-water fishes to low oxygen.

3. The resistance curve of starving fishes which live without food for three to four months. This curve shows a rise in the resistance of the fishes, *i. e.*, a decrease in their susceptibility, during the first part of the starving period; this increase in resistance lasts for from three weeks to two months and then the resistance usually falls off very rapidly and the fish soon dies of starvation.

4. The rate of actual loss of weight in starving fishes has been determined by consecutive weighings, and a comparison of loss of weight and its effects upon resistance in young and old fishes has been made.

5. It has been determined that the reaction of the water, *i. e.*, whether alkaline or acid, has a marked effect upon the resistance of the fishes and the alkaline water seems to be considerably more toxic than the acid in such small concentrations as *N*/3,000 or thereabouts.

6. When the water is alkaline fishes live longer if corked up in the low oxygen water than they do if the water flows constantly through the experimental bottle.

It is expected that some further data will be ready for discussion by the time of the Christmas meeting, as the experiments are being run daily.

Chromosomes in Relation to Taxonomy in the Tettigidæ: W. R. B. Robertson, University of Kansas. (Introduced by B. M. Allen.)

Experimental Modification of the Development of the Germ Cells of Rana: B. M. Allen, University of Kansas.

Compound Chromosomes in Charthippus curtipennis: W. R. B. Robertson, University of Kansas. (Introduced by B. M. Allen.)

Exhibits

The society adjourned, after its session for the transaction of business, on the afternoon of Wednesday, December 29, to examine and discuss the following exhibits which had been arranged in the bacteriological laboratory on the second floor of the Veterinary Building:

Elementary Color Patterns and Their Hybrid Combinations in Grouse Locusts, Robert K. Nabours, Kansas State Agricultural College.

Photographs Illustrating (I) *Experimental Alteration in the Direction of Growth of a Silicious Sponge* (*Stylotella heliophila* Wils.), (II) *Pseudopodia in Sponge Plasmodia Formed from Dissociated Cells,* (III) *Canals and Pores that have Developed in a Sponge Plasmodium,* H. V. Wilson, University of North Carolina.

In the common type of this sponge there is a basal body produced upward into vertical lobes bearing oscula at the summit. If such a sponge be laid on its side, the original oscula gradually close and disappear, while new vertical lobes grow up toward the surface of the water, at right angles to the original lobes. The new lobes bear oscula at the summit.

Wood's Metal Casts of the Recurrent Bronchi of the Adult Lung of the Chick, Wm. A. Locy, Northwestern University.

Sections Showing Pairing of Chromosomes in the Diptera, Charles W. Metz, Carnegie Institution of Washington.

(1) *A Portable Diagram Holder,* (2) *Laboratory Dissecting Pan,* E. L. Mark, Harvard University.

Model of the Pectoral Spine of Ameiurus, H. D. Reed, Cornell University.

Charts and Specimens Demonstrating the Nature of the Intercellular Connective Tissue Substance, Raphael Isaacs, University of Cincinnati. (Introduced by H. McE. Knower.)

Slides for Demonstrating Chromosomes of the Common Fowl: M. F. Guyer, University of Wisconsin.

Symposium

At the session held during the forenoon of Thursday, December 30, a symposium on the topic "The Basis of Individuality in Organisms," was held, C. M. Child, O. C. Glaser and H. V. Neal reading papers, the first speaker approaching the problem from the point of view of the physiologist, the second from that of the physical-chemist, the third from that of the vitalist. Illness in the families of E. G. Conklin and C. E. McClung prevented their attendance. The paper prepared by E. G. Conklin was in the hands of the secretary, but, for want of time, it was not read. It was evident that those who took part in the symposium had given much time and thought to the subject and in the preparation of their papers[1] and a vote of appreciation of their efforts to make the meeting a profitable and enjoyable occasion was voted by the society, and then adjourned *sine die.*

Caswell Grave,
Secretary-Treasurer

[1] It is hoped that these papers will be published in Science during the year.

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE DEPENDENCE OF PROGRESS IN SCIENCE ON THE DEVELOPMENT OF INSTRUMENTS[1]

OUR civilization is requiring for its physical welfare a more and more intimate knowledge of nature's forces. It is demanding this knowledge faster than it is being produced as a by-product in our educational institutions. Scientific investigation is becoming a large business. Governments have established research laboratories; private individuals have endowed others; universities are making more strenuous efforts than ever to encourage research and to make it a real part of their function; and commercial enterprises are finding it profitable to establish research laboratories on a large scale, not being able to wait for the random discoveries from other sources. These facts, alone, show that science is rendering an indispensable service.

The factors which are involved in the solution of scientific problems are in part mental and in part physical. Long experience has taught that however much we may owe to the great minds that evolve basic generalizations and hypotheses, real progress in science ultimately rests on the establishment of facts. Our reasoning faculties, by themselves, are unable to cope with the complexity of the physical world, and are sure to stray from reality unless they are continually guided by observation and experiment. Galileo with his experimental methods contributed more to sci-

[1] Address of the vice-president and chairman of Section B—Physics, American Association for the Advancement of Science, Columbus, December, 1915.

ence than did all the generations preceding him.

Observations made with our unaided senses limit us to the most superficial aspects of natural phenomena; but when we bring scientific instruments to our aid, we throw off these limitations. Not only are we enabled to observe more accurately and more systematically all that our senses ordinarily perceive, but we become endowed with new senses that open up fields of knowledge of which otherwise we could not even have dreamed. This broadened vision constantly brings to light new problems for solution, necessitating new methods and greater refinement.

The greater the advancement in any branch of science, the greater must be the development of the apparatus that is employed. The two are necessarily interdependent. The instrument is to a great extent an index of the state of the science. The greater the precision with which we can make our observations and measurements, the surer we are of keeping on the right path in our interpretation of the phenomena concerned.

I desire to lay some emphasis on this close relationship that exists between the evolution of our ideas and the development of instruments used in science, and I wish to make some suggestions as to how greater efficiency in our work may be attained.

My first purpose will be accomplished by some citations from the history of our science. Let us first recall some simple cases in optics.

Converging lenses are said to have been found in the ruins of Nineveh and must have been made long before the manufacture of glass. They were certainly used at an early date by the Greeks. But the discovery of the combination to form a telescope was not made until 1608; and Galileo soon after constructed telescopes magnifying 30 diameters, which at once led him to important discoveries. The compound microscope originated at about the same time. Without achromatic lenses, both of these instruments were very imperfect. The possibility of making an achromatic lens occurred to Newton, but reliance on a single unfortunate experiment led him to discard the idea. The construction of such lenses by Dollond, in 1757, marks the beginning of a great epoch in the development of optical instruments. It is only necessary to mention the gradual development of various combinations of lenses to bring to mind a great array of most important discoveries which they have made possible, not only in physics, but also in astronomy, in biology, in medicine, and in every natural science.

The pin-hole camera, which led to the idea of photography, was devised in the second half of the sixteenth century. After the image was rectified by means of a mirror and its sharpness and brightness increased by substituting a lens for the pin-hole, this was used quite generally by landscape painters. What flight of imagination to believe that that observed image could ever paint itself! If the idea occurred to some it was brushed aside as a fancy and a dream. Such an accomplishment must forever be beyond the reach of man! No manipulation of machinery could bring about such a marvel. No known forces of nature could be employed. But, as often happens, means were soon found, and what had been considered impossible was realized.

Even before the discovery of the camera obscura the alchemist Fabricius (1556) made silver chloride, and observed that light blackened it. He found that an image of an object imprinted itself upon it. This had no significance to him, how-

ever, and the discovery, although published, was for the time forgotten. More than two hundred years later (1777), Scheele made images imprint themselves on paper that had been saturated with a solution of silver chloride, but these images disappeared when exposed to light. Finally, Niepce, in 1827, produced permanent photographic pictures on metal, and Daguerre improved the method in 1839.

Becquerel and Draper in 1845 independently photographed the Fraunhofer lines, this being the first application of photography to scientific research. Since that day photography has become one of our important new senses and an indispensable instrument of research. Even the long-sought color photography is now a reality.

Spectroscopy presents a good illustration of our subject. That rainbow colors are produced by edges of glass plates was known from the beginning of the Christian era. Glass prisms were manufactured in the seventeenth century, and attempts made to explain the production of the colors resulted in the solution given by Newton, in 1672.

Wollaston, in 1802, observed seven dark lines in the solar spectrum, but Fraunhofer by making larger and better prisms and by using a telescope was enabled to see "countless" numbers of them. He also discovered the bright line spectrum of sodium, superposed, however, over the continuous spectrum of the heated carbon particles present in the flame. He was also the first to make and to use the diffraction grating and to measure the wave-length of sodium light. No explanation of the dark solar lines was given, however, for forty years. After the invention of the Bunsen burner in 1857 many substances could be easily vaporized, and spectral lines were obtained free from the continuous spectrum which confused previous experimenters. Thus spectrum analysis was developed, and the true nature of the dark lines in the solar spectrum soon afterwards demonstrated. The possibility of detecting the motion of stars by the shifting of the spectral lines was considered. This, however, could not be done with the instruments then available. Nothing more could be accomplished until diffraction gratings were much improved.

The original gratings had been constructed of wire, and later they were made with scratches on glass. These were soon perfected sufficiently so that in 1868 Huggins detected the shifting of the dark lines in stellar spectra, beginning a new era in the study of astronomy. The further perfection of these gratings has been most remarkable and the results obtained with them of the highest importance. Even now we feel the need of a still higher resolving power. The problem was, and still is, to get the lines equally spaced with sufficient accuracy for a large number of successive lines. In about 1870, the Nobert gratings, previously used, were replaced by those of L. M. Rutherfurd (1816–1892), who finally made gratings on speculum metal, with a resolving power of 10,000. Rowland (1841–1901) then succeeded in making gratings with a resolving power of 150,000, which advance revolutionized spectroscopy. The gratings now made with the Rowland engine have a resolving power of about 400,000, and the 10-inch Michelson grating, 600,000. These recent improvements in the ruling of the grating, with the added aid of photography, are extending far the limits of a fertile field of research and amassing valuable data for the ultimate demonstration of atomic structure. The time taken through a long number of years to construct an accurate screw was most profitably spent. The same amount of time employed in the taking of observations, in

making hypotheses, or in formulating generalizations, could not have produced results of like significance. It is to be hoped that the probable limit attainable by the present method of construction may be reached, and that we may soon have a 20-inch grating with a resolving power of more than a million.

A technique for making metallic replicas of gratings is highly desirable and should be attempted. The few good gratings that can be obtained only after years of painstaking preparation should be indefinitely reproduced.

Turning for a moment to the subject of temperature, we find that the first thermometer was devised by Galileo and consisted of a glass bulb with an attached tube whose end dipped into water. It measured temperature changes with an accuracy far greater than our heat sense could estimate it, and was truly a wonderful instrument. It made the sense of sight serve the function of the heat sense, and did it better. The original instrument was affected by changes of atmospheric pressure and had an arbitrary scale. These defects were gradually overcome. The bulb was filled with water and the tube sealed. The present fixed points, after many others had been tried, were finally adopted. Mercury was selected as the most suitable liquid for general purposes. The material of the bulb has received due attention, and many modifications of the thermometer for various purposes have been devised. It is doubtless the most common scientific instrument in use. The development of the mercury thermometer has made itself felt in every line of research.

Other means for measuring temperature have been devised. Resistance thermometers, thermocouples, bolometers, and a variety of radiation pyrometers, have made possible investigations beyond the reach of the mercury thermometer.

The development of the nitrogen thermometer and of the thermodynamic scale has placed temperature measurements on a still more scientific basis. The thermodynamic scale has quite recently been extended to 1,550° Centigrade; and all measurements beyond that are still extrapolations based on the law of the thermocouple up to the melting point of platinum (1,775° C.), and on the two laws of radiation for higher temperatures.

The range of temperatures at our control for the study of natural phenomena extends from about two degrees Centigrade above absolute zero to 4,000 degrees, the outer limits being attainable through the invention of the liquid air machine and the electric arc. The oxidation of all materials at high temperatures has made the use of the electric arc impossible for most purposes. A recently devised furnace has overcome this difficulty, enabling experiments to be made in any gaseous atmosphere up to 1,600 degrees Centigrade; and also produces any temperature nearly up to that of the electric arc. The bombardment by cathode rays gives promise of the development of extremely high temperatures for experimental work in a vacuum. The attainment of the lower limit of temperatures has made possible the most wonderful discovery of "superconductivity," which, with the investigations on conductivity at high temperatures, adds most significant data toward the development of the theory of electric conduction.

The bellows, the siphon, the water pump, the fact that water is supported in a filled inverted bottle when its mouth is in water, and various other phenomena, were explained on the principle that "nature abhors a vacuum." The invention of the barometer by Torricelli (1643) almost

immediately enabled Pascal (1647) to prove the falsity of this principle and to establish the correct foundation for the theory of hydrostatics.

The invention of the air pump made possible a whole series of investigations. Recently we have been impressed with the invention of several forms of pumps which enable us to obtain very high vacua with great ease and rapidity. The importance of such appliances must not be overlooked. Time is a most important asset for the investigator.

I wonder whether we appreciate what we owe to the great accessibility and continual improvement in manufactured materials. What a luxury we have in insulated wire! How could we do without glass tubing! We recall with what difficulty Pascal procured a tube for repeating Torricelli's experiment. Now we have even quartz tubing and quartz vessels of all kinds. The recent discovery of producing tungsten in a ductile form has made that element indispensable for some purposes. Fibrox, a new material not yet purchasable, is an improvement on all heat insulators. Manganin wire, with its application to all kinds of electrical instruments, has made electrical measurements of high precision comparatively simple. But it is not necessary to enumerate further.

Turning now to electricity for our examples, we find that the electroscope has developed from the pith balls and the simple gold leaves into a variety of very sensitive instruments, and the Thomson quadrant electrometer, into that of Dolezalek. The string electrometer makes it possible, for the first time, to measure rapid changes of a charge.

One of the great conveniences of a modern laboratory arises from the high state of perfection of current-measuring instruments. Galvanometers which are already highly developed are still continually being improved. In the moving coil galvanometer higher sensitivity is being attained, and efforts are being directed specially to obtaining a greater constancy in the zero reading and a greater uniformity of the radial field. The development of the galvanometer and of the methods of its standardization are of extreme importance to research.

The electric condenser, which was first made without regard to absorption, has gone through the stage where it was considered an improvement to saturate the dielectric with moisture, then where, in the process of construction, the condenser was boiled in a vacuum; to the present method of boiling at the highest possible temperature, and then subjecting to high pressure. Many problems in the development of the condenser still remain to be solved. The better elimination of the absorbed charge would add greatly to its use as a precision standard for the measurement of the electric quantity, and would be of great importance wherever condensers are employed with alternating currents.

The recent developments for excluding moisture from resistance coils, and for rendering them free from capacity and self inductance, show that advancement even in the construction of resistance standards is still in progress.

The Crookes' tube has resulted in the discovery of the X-rays, which are now proving of such great service not only in medicine, but in the study of atomic structure and of atomic distributions in crystals.

The human voice was first transmitted by electricity in 1876. The rapid conquest, since that time, of the almost insurmountable obstacles of long-distance telephony has been due to progress in many lines of research and to the large number of workers striving for the same end. The present

transcontinental telephone line is 3,400 miles in length and transmits speech without distortion. The chief factors that have contributed to this result are the Bell receiver, the microphone, the coils for preventing voice distortion, and finally the invention of the thermionic amplifier.

The twenty-fifth day of January of this year marks the beginning of transcontinental telephony by wire and September 29 that of transcontinental telephony without wires, both great achievements having been accomplished in our own country and since our last annual meeting.

The experimental proof that the condenser discharge is oscillatory and Maxwell's (1831–1879) theory of electromagnetic waves led Hertz (1857–1894) to devise the apparatus which demonstrated the existence of such waves. The value of these purely scientific efforts is seen in the result. It was found that connecting one end of the vibrating system to the earth and the employment of long antennæ improved the sending power of the transmitter; and the development of detectors improved the receiving apparatus. We have then, as applications, the wireless telegraph which is rendering such unusual service; and finally, with the development of the thermionic amplifier, already mentioned, the wireless telephone which has so recently enabled the human voice to travel across our continent and beyond to Honolulu, a distance of 4,850 miles.

A modest-looking little bulb containing a stream of almost inertialess particles known as the thermionic current would hardly have been suspected of being able to bring about, as it has, so important a step in the development of long-distance telephony of both kinds. By means of this little instrument, or rather many of them, the energy of the original telephonic current can be increased many billion times, which is then transformed, in part, into ether tremors and sent in all directions across oceans and continents and there transformed again, reproducing the original speech without distortion. Our sense of appreciation seems to have been hardened by many and great successes. We seem to be stunned, unable to comprehend fully the significance and the greatness of such a marvelous achievement.

Apparatus has been devised for the counting of both the alpha and the beta particles, and the existence of atoms has been demonstrated beyond question. The simplicity of the apparatus devised by C. T. R. Wilson for making visible the paths of the alpha and the beta particles, atoms and the minute pieces of atoms, makes us wonder whether anything is impossible, providing we have the genius to devise the proper instruments.

Radioactive substances would be exploding with stupendous violence, and their quivering atoms be sending ether pulses into space, a whole world of great activity about us, and we should be in complete ignorance of it, were it not for the electroscope and the photographic plate.

As was intimated at the beginning, this partial summary has been presented mainly for the purpose of illustrating the extent to which the development of instruments has been a contributing factor in scientific progress. It is to be noted that in many cases advancement can proceed to a certain point and then must necessarily stop, no further significant progress being possible until some required instrument of research is perfected or an entirely new one devised. It is often more profitable to devote time to developing instruments than to the continuing of investigations whose results become obsolete as soon as the instruments employed are improved. The painstaking observations of Ångström, notwith-

standing their great value, were discarded as soon as better gratings were produced.

The simplest of instruments have often been the means of making great discoveries. Faraday and Henry worked with the most simple tools. Many discoveries as far reaching as any will again be made with the simplest apparatus; but advancement in other directions can only be effected after the highest possible development of instruments and processes.

Some men by devising what appeared to be a little improvement in a machine have indirectly advanced science more than would many painstaking investigations. Instruments like the Crookes' tube lead to the discovery of facts that were entirely unsuspected and unsought; and similarly many instruments have been developed for one purpose and then found to be of value in an entirely different field. We have seen many problems solved which at first appeared beyond the possibility of demonstration or accomplishment. There seemed no possible method of approach. There were no instruments with which the results could be attained. Photography, wireless telephony, counting atoms, and seeing the tracks of atoms and of fragments of atoms, are some of the accomplishments which not so many years ago would have been considered beyond the range of possibility.

Many instruments are used as tools to perform certain definite functions in a more complex system, and, as such, should be so constructed as to require the least possible attention. As far as it is practicable the instrument should read directly the quantity desired. We already have many such instruments, as, for example, the ammeter, voltmeter, fluxmeter, potentiometer, Wheatstone bridge, direct reading spectrometer, and the recently devised instruments for giving directly the length of electromagnetic waves and their logarithmic decrement. The "artificial eye," also recently devised, gives in the photometry of colors results equivalent to that of an average eye, eliminating the necessity of several observers. In the measurement of conductivity an apparatus has been so assembled as to give directly the resistance in microhms per cubic centimeter. Self-recording instruments of all kinds are a great convenience and in many operations practically indispensable.

The intricacy and difficulty of many operations which often retard progress should be removed as far as possible. Every instrument improved to give greater convenience and greater simplicity in operation, makes it possible for all who use it to concentrate their whole energy on that part of their work which has real significance. This adds much to efficiency and productivity in science.

I wish to emphasize the importance of using the best and most convenient instruments obtainable for any given purpose. We may learn from manufacturing establishments the advantage of discarding apparatus that has become obsolete or not suited for our particular purpose. In no other way can our output become what it should be.

There are many problems pressing for solution, and every unexplained phenomenon may hold in store still more problems or strange relationships and unknown entities. Most of the solutions can be made only with the aid of scientific instruments.

We want to know something definite about the nature of gravitation and of the ether. We want to understand more completely the structure of atoms and molecules. We want to know the structure of corpuscles and nuclei. We want to understand the interatomic and intermolecular forces. We want to know what determines

the various properties of the different elements. We want to understand the nature of positive and negative charges of electricity. We want to know the nature of electric and magnetic fields and the relation between the two. We want to know a great deal more about the mechanism of radiation.

We must find a way of obtaining power from coal more economically. The direct energy of the sun should be employed and stored for use at night and in winter. The energy of the tides and of the wind must be economically utilized. These and a thousand other problems are waiting for solution.

The ultimate aim of science, as I see it, is to solve the mysteries of nature not only for the purpose of broadening our vision of the external world and for making its forces serve our physical needs, but also in so doing to help guide us to a fuller understanding of our relation to the universe and of the miracle of our existence. May we not ultimately learn something definite about the relation of mind and matter?

We must place no limits to the possibilities of science. Speculation and the imagery of what may lie beyond the present boundaries of knowledge are an incentive to greater effort, and are of real value when given their proper place.

I have called attention to the importance of instruments in scientific progress. I have emphasized the importance of perfecting the instruments, not only with regard to greater precision but also with regard to convenience in operation, so as to enable new ideas to be subjected to experiment with the least possible effort.

The vastness of our field and the interdependence of the different branches make it impossible for any one individual or a small group of individuals to be familiar with all the known processes and instruments for accomplishing definite ends. Our investigations often lead to the determination of some quantity we are not accustomed to measure, and we wish to know at once what is the most practical apparatus to employ. Much time is often wasted in devising an instrument that has already been developed, and inefficient devices are often finally employed unnecessarily. When we consider the large number of investigators concerned and the importance of the work, this is a serious matter. We may obtain help from the catalogs of manufacturers, we may write to some one who is more familiar with such measurements, we may search in various scientific books and magazines, technical handbooks, and reports of the bureaus of standards. Such procedure, however, is wasteful and uncertain, and as has already been stated, often leads to the employment of inferior and more cumbersome methods than is necessary. It is like searching for the meaning of a word from its use in literature, in place of using a dictionary, or like searching for physical constants in the original publications, in place of using compiled tables. It is like these, except that it is much worse. Most instruments and methods are described under the titles of the investigations in which they were first employed, which, in addition, are often published in inaccessible journals.

We need what we may call an *encyclopedia of instruments and methods of research*. This should include materials, methods and processes, as well as individual instruments employed in research in all the sciences. Progress in the development of apparatus is so rapid that it would be necessary to issue a yearly supplement and probably to publish a revised edition every few years. This could be done by some bureau or organization with the cooperation of all scientific men. In the simplest form it could give the apparatus and the different methods for accomplishing each definite purpose, a short statement concerning each instrument, with references to

journals where it is fully described, and all improvements to date. If it was desired to produce a low vacuum, all the known methods and the limitations of each would be at once found in such an encyclopedia. If one wished to measure low pressures, the encyclopedia would call his attention, with references, not only to the McLeod gauge but also to the recently devised molecular gauge which might give more accurate results in those particular measurements. If one wished to maintain a constant temperature at several successive points from the temperature of solid carbonic acid to that of liquid air, he might spend a long time in devising an apparatus, but the encyclopedia would at once refer him to the methods that have been successfully employed. Such a publication would add much to efficiency, and the cost would be small compared to the great service rendered to science.

We also need a *journal of scientific instruments,* in English, devoted entirely to the description of new methods and instruments.

I have often felt the need of both such publications, and I am sure that much energy now wasted would be conserved, and on the whole more worthy contributions to science produced. When once accustomed to such necessities we should wonder how we managed to do without them.

We are entrusted with the responsibility of solving some of the greatest and grandest problems confronting the race. It is our plain duty to be improving conditions for individual and general efficiency. We must point out the needs of science in definite and concrete terms, and must not hesitate to urge upon society that it supply all real physical needs for the proper prosecution of its scientific work.

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PSYCHOLOGICAL AND HISTORICAL INTERPRETATIONS FOR CULTURE[1]

THE mere fact that we have in Section H a joint segregation of anthropology and psychology would seem to imply some close functional relation between these sciences. However, the most probable explanation of the phenomenon is to be found in the distinctly anthropological conception of historical association. If one may be pardoned the diversion, I would say that most likely this association is due to the shrewdness of some one in finding a chance to smuggle psychology into the scientific camp. Yet, if one recalls the various annual programs of the section, there comes to mind a considerable number of papers and addresses professing to authoritatively interpret cultural phenomena by the aid of psychological conceptions. So far as I know, the authors of these papers have all been psychologists, rarely has an anthropologist ventured to set the psychologists right. Many of these psychological discussions of anthropological problems have struck the anthropologists as a bit naïve and I have not the least doubt but that for once, the psychologists will in turn get a naïve reaction, because I propose to present reasons for doubting the validity of such psychological explanations for cultural phenomena.

We have a considerable bibliography under the heads of psychology of religion, psychology of art, psychology of sex, and psychology of society. Of these the professional psychologists have the first two almost entirely to themselves, but share the others with the sociologists. In the development of their subjects, the psychologists

[1] Address of the vice-president and chairman of Section H, Anthropology and Psychology, American Association for the Advancement of Science, Columbus meeting, December, 1915.

have as their fundamental assumption the belief that religious phenomena are susceptible to statement in psychological terms and that their ultimate explanation is to be sought in conventional psychological principles. By analysis, they seem to seek for a psychological mechanism, or a fixed association of activities, that is responsible for the appearance of religion on the earth and its subsequent development. One of their initial assumptions is that by this mechanism, or whatsoever they prefer to call it, man has gradually built up the religion of the world to-day. They take for granted that the religions of the less civilized peoples of our time are examples of the earlier forms of this development, and seek in them the fundamentals of religious evolution. The chief aim is to show how the religious activities of our people can be explained as normally evolved from the functioning of this assumed mechanism. It follows that one of these psychological authors would consider his task brought to a glorious end if he could formulate a statement of the gradual building up of religion that was entirely consistent with the data at hand; and would consider that he had revealed the cause of its appearance to lie in a definite mode of action in man's nervous system.

Though we have so far spoken in terms of religion, the general assumptions in the treatment of art, sex, etc., appear to be the same. All these psychological investigators are striving to bring the phenomena of culture entirely within the conventional limits of psychology and to explain it by psychological principles.

In order to bring out clearly the differences between this attitude and that now assumed by our representative anthropologists, we may try to apply the same mode of characterization to their works. I do not recall any serious recent attempt on the part of an anthropologist to discuss the anthropology of religion as a whole or to examine our own religion by anthropological tools, but if the attempt were to be made, the preconceptions would be about as follows. In a treatise on our religion, the phenomenon would be considered adequately explained by identifying it with culture. Culture origins would be sought in a comparative analysis of our religion and in tracing out the sources from which the various elements in the complex came. The ideal would be to state where, among whom and under what conditions, these several elements arose and were associated in the present complex, the whole constituting what may be considered as a historical explanation. It is not conceived that the carrying of this analysis to its ultimate extreme would give us a statement of religion as a world phenomenon, for the religions of other peoples have different histories, and though we see on every hand indisputable evidences of mutual borrowing and interaction, the fundamental elements of the world's religions have decided individuality. Hence, if we confined our efforts to tracing out the historical development of only such elements as are found in our own religion, we should ignore a considerable part of the phenomenon at large. Therefore, a general treatise on the anthropology of religion would begin with the exhaustive study of a number of religions and finally seek by a comparative view, a generalized statement of the historical relations between the religions of the world. Thus could be constructed a theoretical outline of the development of religion as we now find it among the several peoples of the earth. On practically the same lines we should expect to develop the anthropology of art, literature, music, marriage, social organization, etc.

Now if these are true characterizations

of the two methods, it is clear they have important differences. Both use the same data as to the kinds of religious activities in the world, but the psychologists seek their origin in universal psychic activities, while the anthropologist is content to find the approximate localities and relative times whence the various elements come into view. Though perhaps not at first apparent there is nevertheless a fundamental difference between the two, which it is my purpose to develop in this discussion.

Like psychology, anthropology has been rapidly developing its problems and conceptions, and is just emerging from its formative period. Its position and scope is perhaps as clearly formulated now as is that of psychology. In the main, it deals with culture and the various problems directly related thereto. Anthropology is perhaps most correctly defined as dealing with the first appearance and subsequent career of man upon the earth. While comparative morphology in all its human aspects is an important method, it is based upon and dependent upon other sciences and has for its ultimate goal the elucidation of historical cultural relationships. Culture is the distinctly human trait and must always be appealed to to determine the status of such fossils as the *Pithecanthropus erectus.*

Cultural phenomena are conceived of as including all the activities of man acquired by learning. Thus we eliminate, on the one hand, the permanent individualities of the separate men and, on the other, whatever equipments they may have had by birth. Cultural phenomena may, therefore, be defined as the acquired activity complexes of human groups.

It follows, then, that there is a problem of almost equal concern to psychologists and anthropologists—the differentiation between the innate and the acquired. Psychologists give their attention to innate phenomena, especially man's psycho-physical equipment. If we extend the meaning of the term behavior so as to include consciousness, we may say that psychologists are concerned with the behavior of man as an individual. If one may trust to the remarks heard, psychologists are quite given to the assumption that anthropologists are simply students of comparative human behavior. At least psychological literature contains more than one example of the behavioristic interpretation of cultural data. Now, it may be that there is a problem in the comparative behavior of the individuals comprising ethnic groups, but, if so, it is a psychological one and must be solved by the use of psychological data. Anthropologists give it little concern because they see in differences of individual behavior no significant cultural correlates. So far as they can see, all the known culture phenomena since the dawn of the paleolithic period necessitate no changes in man's innate equipment nor in his innate behavior. So, on the whole, anthropology is quite indifferent to the problems of comparative behavior, because it is concerned with the objective aspects of what is learned in life.

There is, however, one problem that troubles the anthropologists, viz., to distinguish between the innate and the acquired elements of the more fundamental activity complexes. One of the pressing anthropological problems of the hour is the effectiveness or non-effectiveness of instinctive factors in the differentiation of cultures. The problem is almost identical with the educational problem of inborn *versus* learned activities. The only systematic discussion of this problem is Thorndike's "Original Nature of Man," which, while projected from an educational horizon, is, nevertheless, a distinct contribution to the anthropological problem. One of

this author's illustrations may be cited as an example of the anthropological problem: thus we are told "that a child instinctively conveys food to his mouth with the naked hand, but by habit comes to use a spoon" (p. 3). Here it is clear that the use of the spoon in eating is a cultural fact in contrast to the use of the hand. As such, it falls into the same class with forks, saws, rifles, automobiles, etc., or into the general class of tools. A little reflection or a visit to an anthropological museum will show how completely tools dominate the objective phenomena of culture. Yet, our problem is far from simple. For example, what shall be said when the baby grasps the spoon and pounds upon the table with every manifestation of joy? Is pounding a phenomenon of culture or is it a part of original nature? The anthropologist very much needs to know where the distinction falls. He has at various times given it serious consideration, but finds no way to approach it save by logical analysis, resulting in the formation of an opinion. It seems that psychologists have done no better. Thorndike, for example, is delightfully frank in stating that in most cases as yet he is able to do little more than formulate an opinion. His general statement seems to be that while original nature often decides that an individual will respond to certain situations, it far less often imposes upon him a definite response or limits the time of such response. To this, as a generality, anthropologists will agree: it is in fact another way of stating their own opinions. To them its formulation would be something like this: while all culture is acquired, there must still be a complex of instincts to acquire and participate in cultural activities; but only very rarely, if at all, specific instincts for the acquisition of a particular culture. While such generalities are of great value, serving to clear the air as it were, they unfortunately solve no problems nor relieve us of the necessity for real concrete investigation.

Reverting again to the tool-using complex, the anthropologist is quite ready to assume that to seize any convenient object and use it to assist movement is instinctive; and more, that the tendency to observe the specific use of tools by others and self-learn the use of the same, is in its fundamental aspects instinctive. Finally, there is a presumption that there is some instinctive factor in the invention complex, that leads to the production or modification of culture traits. That there must underlie the development of cultures an instinctive complex tending to culture production seems a necessary assumption to those familiar with anthropological data.

One general point about which psychologists seem to agree is that the associations of ideas are not innate. This is expressed by Thorndike (24) as follows:

> It is unlikely that the original [innate] connections are ever between an *idea* and either another idea or a movement. No one has, I think, found satisfactory evidence that, apart from training, an idea leads of inner necessity to any one response. And there is good evidence to show that original connections are exclusively with sensory situations. . . . We have, of course, by original nature the capacities to connect the idea of one thing to the idea of another thing when the two have been in certain relations, and to break up the idea of a total fact into ideas of its elements, when once ideas have been given that are capable of such association and analysis. But we do not apparently, by original nature, have preformed bonds leading from ideas to anything. If an idea apart from training provokes a response, it does so by virtue of its likeness to some sensory perception or emotion. Nor do we apparently by original nature respond to a situation by any one idea rather than another. *That* we think is due to original capacity to associate and analyze, but *what* we think is due to the environmental conditions under which these capacities work.

The *what* we think is largely determined

by our culture, for, so far as anthropologists can see, a culture is a definite association complex of ideas. When anthropologists assert that culture is not innate, they have this in mind and should, if it were true that definite associations between ideas were innate, find it difficult to harmonize these contradictions. The assumption, therefore, that it is chiefly between sensory factors that inborn connections exist, is complementary to the anthropological view. In content, culture is highly rationalistic, or fundamentally a matter of thought, or idea connection. There is, however, considerable confusion on this point, apparently due to lack of discrimination as to the thinking process and what is thought. As we have already noted, the individual's attitude toward culture is apparently entirely an innate affair, or is truly a part of his innate behavior. The obscurity of the case arises in part from the fact that it is this innate behavior that produces cultures and perpetuates them. It is quite natural, therefore, that many should claim the non-rationalistic factors as cultural. We have various fairly satisfactory theories of culture origin based upon the conception that man's less material traits are rationalistic constructs from instinctive actions, the latter serving as the suggestive structural elements. Our contention here is, however, not on the reality of an instinctive basis to culture, but that the investigation of man's true behavior is a psychological problem and must be approached from the psychological horizon. The moment we, as anthropologists, attempt to apply cultural data and cultural methods to these underlying instinctive phenomena, our psychological friends will find our assertions just as naïve as theirs to us when they reverse the application. Since we can not expect to be at home in the psychological field, we must leave those problems to them.

Perhaps in passing we should note the much-discussed question as to the power of ideas, for many psychologists vigorously insist that an idea can in some way lead to action irrespective of other conditions. Now it may be that every idea causes a reaction, as to that an anthropologist's opinions are of no importance, but such acts seem to fall into the behavior class and belong, therefore, to the innate equipment of man for cultural activity.

We are familiar with the fact that all the known cultures of the world have certain marked similarities; in fact, from one point of view, they are very much alike. It has been claimed that this likeness is due to many fundamental ideas in common. Bastian seems to have believed that these ideas were to be found wherever people lived, because the very constitution of their nervous system made them arise with certainty. Now, if this is true, such ideas must be set down as part of man's original nature. If they result as a universal response to situations, the situations must be uniform; but in any event, if all men, however isolated from birth, will get these ideas, then they are essentially inborn and so constitute the basic elements of culture.

We may also note the older belief that man's original nature was so ordered that social groups everywhere tended to develop their culture on the same pattern, rising from the lowest state of savagery to the highest civilization. This again, if true, would necessitate a kind of mechanical view, for we make the whole merely a response on the part of man's original nature.

However, these views are quite antiquated. We now have the rival theories of independent development and single origin of culture traits. In response to the independent versus common origin of traits, we have such compromise theories as convergent evolution, limited possibilities, etc.

The problem confronting these theories is to identify the causes underlying the observed similarities of culture traits.

It is clear that the theory of a single origin for even the most widely distributed traits assumes no necessity for the inheritance of particular ideas. The theory of independent origin when invoked to explain the occurrence of certain traits in large distinct areas as in both the Old and New World, is also consistent with the unoriginal nature view; but when pushed farther and made to account for the separate appearance of a trait in many places, leads its supporters into an embarrassing position. When we assume a single place of origin for a trait, we take the view that its appearance is accidental. Thus, original nature offers no explanation for the event, only a historical account of what transpired in the place and time will suffice. For example, some anthropologists are of the opinion that the bow was invented but once and thence found its way gradually over the world by diffusion. (This seems likely in view of the known history of firearms.) In such cases, it appears that the invention and its development in one place is due to the chance combination of many causes. Underlying it is an idea whose occurrence in the mind of an individual was truly accidental. I have elsewhere referred to this view as the psychic accident theory for culture origin. Now the difficulty in extending the independent origin theory to many small areas is that we have too many accidents, unless one can show that the possibilities are limited to a few alternatives and that all men will be made aware of the same kind of situation. However, few anthropologists take the extreme view that all occurrences of the same trait are due to independent invention, the general tendency being, when a trait has a continuous distribution over an area, to consider it as having been diffused from one point or center included in, or contiguous to, the area in which it is found. Thus, that the bow may have been invented in two or three parts of the world is conceivable without doing violence to our experience with chance phenomena; but, if we go on and divide up the world into small units we soon reach a point where we must find other than accidental causes. The defenders of the independent theory recognize this, for practically all resort to the assumed unity of the human mind to account for the frequency of widely distributed traits; but when they do so they put themselves into a position where the denial of direct dependence upon original nature is next to the impossible.

In general, if we take cognizance of psychological knowledge, it appears that so far all attempts to explain particular culture traits as due to the unity of the human mind have been abortive. On the one hand, we have no psychological evidence that particular ideas are due to particular psycho-physical biases—in fact there is abundant evidence to the contrary—while on the other, we have the obvious fact that cultures do differ and that one of these common culture traits when displaced soon passes into oblivion or does not recur. For example, how many of us would ever have conceived a bow, if the thing were not taught us? Further, the unity of the mind theory ignores the great unity of the physical world which certainly controls many traits of culture. Thus, the problem of cutting has but one ready solution, a material harder than that to be cut and a knife edge. This is due to the physical unity of the world. Hence, whenever men happen to solve this problem, their solutions tend to similarity in the essentials of cutting tools; but if the unity of man's mind predetermined the solution, why should we

have such a variety of cutting tools as we find in our museums? The unity of mind seems to be an expression for uniform behavior and applies to the original nature of man. To explain facts of culture by asserting the unity of the human species, is little more than the useless pleasantry that culture exists only because there are men in the world. But one may retort that a psychology of religion, or what not, seeks to discover precisely why these ideas arose or were so associated. Our contention is that this can be done only by knowing the history of the case and that this history can not be reconstructed from an ensemble of culture traits, however minutely they may be described in psychological terms.

In the various aspects of the tool traits of culture we have one of the most important series of data bearing upon both the psychological and the anthropological problems of culture origin. It is perhaps less fundamental than language, but is objectively superior because of the indestructible nature of many types of tools. For example, we find in the cave deposits of western Europe, some of man's first stone tools. We have previously noted the probably instinctive basis for tools. Thus, it may be granted that man is by original nature a tool-using and tool-wanting animal. Yet it is difficult to determine if he is a tool-maker by original nature, for the tool-making complex appears as only the mechanical adaptation of natural forms in which materials are found. It has been shown by anthropologists that many forms of stone tools are but slight modifications of selected pebbles, whose natural shapes were adapted to the specific purpose for which tools were sought. The same general principle holds for all tools, for the maker has to adapt his methods to the mechanical properties of the original materials from which the tools were to be made. This adaptation is surely the rationalization of experiences arising from original responses to tool-using situations. This invention, or the production of new traits of culture, may itself be rationalized, as is the case when we deliberately set ourselves an inventive task, or even when we recognize the inventive process as a method of culture production. All this must be granted, but there are innumerable times when new conceptions come as the normal undirected activity of thought. So it seems that rationalization must as a process be original or a part of man's original nature. We see that culture production, as the devising of tools, etc., is a product of the rationalizing capacity of man, which in turn is a part of his original nature. Therefore, there is good reason for assuming an underlying innate basis for tool-making in particular and culture production in general.

This clears the way to a fundamental problem: viz., the origin of culture. If culture is a matter of ideas, or the functioning of the rationalizing mechanism, then the first prerequisite to the observed condition is the appearance of an anthropoid with this element in his original nature. The forms and varieties of cultural remains seem to necessitate from the first the existence of this rationalizing power at its present level. Thus, it may be objected that the forms of stone tools found in the oldest cave deposits were produced by instinct alone, just as the spider spins a web or the bee fashions a comb. The answer to this lies in our museum collections where we find considerable variety in form in a given deposit, but particularly in the many sudden and abrupt changes as we pass from one stratum to another. Then again, Australian natives were but recently observed making forms identical with some of paleolithic origin and with them the instinctive explanation would be absurd. Their

method of learning the art and their mechanical attitude toward it is as rationalistic as similar homely arts are with us. In brief, we fail to discover any essential differences in the tools of early man and those now made in a rationalistic manner; hence we can do no more than assume that from the first they were mere inventions. There may be, however, very great differences in the intensity of rationalization between our ancestors and ourselves, but it is difficult to see how even the earlier cultures we know could have taken form without the same qualitative rationalizing power. Further, one of the questions anthropologists would like to hear discussed is as to whether the assumed greater intensity of modern rationalization is not merely apparent, only the accumulated momentum or the complex of short-cuts our culture has developed. Anthropologically, it seems that the phenomenon is entirely one of accumulation and short-cuts; but this may be found incompatible with psychological and biological data.

Returning now to the question of a tool-using instinct as previously stated, it may be objected that this also is but a rationalization or invention, and so not innate. Now at least grasping in the hand is innate and so is the picking up of objects. Then since there is certainly an innate striking response, we have at least the necessary elements of instinctive activity. Though we are here dealing with a problem yet to be solved, my own observation seems to justify the assumption that to seize an object and pound with it rather than the hand, is an innate phenomenon even in very young children. As suggested above, anthropologists favor the view that no mechanical movement complexes for tool-making are innate, but that there is in man's original nature a mechanism that lays hold of things and thus supplies the basis for self-rationalization and for the acquisition of the great store of accumulated rationalizations of the race, or culture.

The point we are coming to is that the anthropological conception of culture is entirely consistent with the psychological view, for it asserts that neither mental bias nor biological attributes are of the least avail in explaining the origin of specific culture traits and that it is only when we know the history of a case that we can give anything like an adequate account of its origin. It is thus clear that when we are dealing with phenomena that belong to original nature we are quite right in using psychological and biological methods; but the moment we step over into culture phenomena we must recognize its historical nature. This is why anthropologists object to much that passes for the psychology of religion, art, etc., in which many of the results obtained by use of the historical method are put on a level with those obtained by other methods, and then interpreted as facts of evolutionary or other non-learned activities. To them such terms as psychology of religion, psychology of society, of law, of sexual restrictions, etc., are often so used as to be worse than meaningless for they at once assert what is contradictory to psychology itself.

We are now ready to consider the value of psychological explanations for culture origins. We often read that if culture phenomena can be reduced to terms of association of ideas, motor elements, etc., there remains but to apply psychological principles to it to reveal its causes. This is a vain hope. All the knowledge of the mechanism of association in the world will not tell us why any particular association is made by a particular individual, will not explain the invention of the bow, the origin of exogamy, or of any other trait of culture except in terms that are equally applicable

to all. What more can psychology tell us than that these inventions were thought out by somebody. So when a culture complex has been analyzed and found to rest upon the association of two or more ideas, we do not thereby raise a specific psychological problem at all. The problem we do raise is as to where and at what relative points in man's career did these ideas appear, and the solution is to be sought in the historical relations of the people among whom they originated and not in innate psychological characters.

Our purpose is not to deny the existence of a psychological problem in culture; far from it. We are only pointing out what aspects of the problem can consistently be subjected to psychological methods and calling formal attention to the very crude method of taking learned activities for innate ones and thereby explaining cultural phenomena. Psychology can be of the very greatest service to anthropology by discovering the relations between man's innate and cultural equipments.

CLARK WISSLER
THE AMERICAN MUSEUM
OF NATURAL HISTORY

CHARLES RENÉ ZEILLER

LORRAINE has produced many men who have adorned the annals of the sciences, arts and politics of France. None are more worthy of honor than Professor Zeiller, the dean of paleobotanists, who passed away at his home in Paris on November 27.

Born at Nancy on January 14, 1847, he was educated at the École Polytechnique and École des Mines, so that naturally he was a member of the auxiliary corps of engineers during the Franco-Prussian war. His father was engineer-in-chief of bridges and highways of Lorraine and on the maternal side he was descended from the sculptor Guibal.

Although the illustrious mantle of Brongniart and Saporta has long rested on Zeiller's shoulders his earliest contributions were not paleobotanical, but metallurgical and geological, and published in the *Annales des Mines* in 1870 and again in 1871, both devoted to the Eifel region. In 1873 he published a memoir on the eruptive rocks and metalliferous veins of the Schemnitz district. His first paleobotanical contribution was an analysis of Schimper's great work, "Traité de Paléontologie végétale" and published in the *Revue scientifique* in the spring of 1874, thus indicating the trend of Zeiller's mind at that time and foreshadowing the field of endeavor to which he was to so successfully devote the mature years of a reasonably long but never robust life.

As an engineer of mines the fossil floras associated with the coal were the subject of his chief professional interest, although Zeiller was not a narrow specialist, but a contributor to all phases of paleobotanical activity. With a rare facility he was equally effective in describing the histology of *Sphenophyllum* and *Lepidostrobus* or the impressions of plants of the Paleozoic, Mesozoic or Cenozoic. The last paper from his hand that I have received was an account of the Wealden flora of Peru, and in his last letter, written just before the end, he asked me to send him a copy of Walcott's recent paper on Algonkian Algæ. It was this world-wide interest combined with a philosophical temperament that made the many annual reviews of the progress of paleobotany published in the *Annuaire universel de Géologie* and the *Revue bibliographique* of such lasting value.

Zeiller's first original contribution to paleobotany was an account of the flora of Ternera in Chili published in 1875, and the wide interest and facility of treatment are shown in a succession of works whose stratigraphic range is from the Devonian of Pas-de-Calais to the Tertiary of Tonkin-China, embracing discussions of floras of the Carboniferous, Permian, Triassic, Jurassic, Cretaceous and Tertiary. Outside his native land he contributed to the paleobotany of Spain, India, the Vosges, the Balkans, New Caledonia, Indo-China, Madagascar, Central and South Africa,

Brazil, Peru, Chili, Persia, Russia, Asia Minor (Heraclée) and China.

Professor Zeiller was one of the first to demonstrate the precision with which fossil plants can be used in stratigraphic geology and in the numerous large memoirs on the Carboniferous and Permian floras of the coal basins of Grand-Combe (1884), Valenciennes (1888), Commentry (1888–1891), Epinac (1890), Brive (1892), Blanzey and Creusot (1906), as well as in his work on the fossil plants, which forms part 2 of Vol. 4 of "Explication de la carte géologique de la France" (1879), he displayed a philosophic interpretation that had never been equalled. Since 1878 the mining engineers of France have had the benefit of his annual course in paleobotany at the École nationale des Mines, the excellence of which is attested by his "Éléments de Paleobotanique" published in 1900, which remains not only the best but the only well balanced text-book on this subject that has ever been written.

Professor Zeiller was not only a voluminous contributor to his chosen science, but a life-long teacher and a conscientious and efficient administrator, having been for more than twenty years the secretary of the National Board of Mines, Inspector General since 1884 and Vice-president since 1902. He had charge of the *Annales des Mines* from 1874 to 1910. For a period of forty-five years he was an honored member of the *Société géologique de France* and its president in 1893. Honors came to him freely both at home and abroad. He was a commander of the Legion of Honor and a member of the French Academy since 1901. Cambridge conferred its Sc.D. on him at the time of the Darwin Centennial.

Professor Zeiller was a sort of father-confessor to the younger paleobotanists of all races, and they found in him a wise and kindly critic, always painstaking and helpful, as well as a generous and inspiring friend. His rare ability was combined with an equally rare modesty that endeared him to a wide circle on this side of the Atlantic, and wherever fossil plants are studied his name will ever be honored. This is neither the time nor the place for a critical analysis of his contributions to science—our grief is too recent. That he upheld the high traditions of French paleontology there can be no doubt. His epitaph might well read *Nil nisi bonum.*

E. W. B.

RECOMMENDATIONS OF THE PAN-AMERICAN SCIENTIFIC CONGRESS

The Second Pan-American Scientific Congress at its final session before adjourning to meet again at Lima in the year 1921, which will be the Peruvian centenary, adopted by unanimous vote thirty-six recommendations. Those relating to the sciences are as follows:

I. That it is highly desirable that the various American republics arrange for the appointment of delegates for joint action in the matter of archeological exploration, in order to formulate generally acceptable and substantially uniform laws relating to the survey, exploration, and study of archeological remains to be found in the several republics, and that laws shall be enacted which will effectively safeguard these remains from wanton destruction or exploitation and which will serve to aid and stimulate properly organized and accredited research in archeology.

II. That the government of the United States be requested to bring to the attention of the governments of the other republics participating in the congress and, through their respective governments, to the institutions and the public thereof, the importance of promoting research in the field of archeology, organized surveys for the study of primitive tribes, and the building of national educational museums for the preservation of the data and materials collected.

III. The American republics undertake as soon as possible: (*a*) Accurate, geodetic measurements which may serve to determine limits, national and international, and to contribute to the discovery of the true shape of our planet. (*b*) Magnetic measurements of their respective surfaces, and the establishment of several permanent magnetic observatories in which it may be possible to carry on during long periods of time observations concerning the secular variation of the magnetic characters of the earth. (*c*) To extend their gravimetric measures (obtained by means of the pendulum)

to those regions where these measurements may have not been taken, in order to obtain more information to determine the true shape of the surface and the distribution of the terrestrial mass.

IV. That the nations of the American continent establish, by means of their offices of geodesy or by committees appointed for that purpose, an international triangulation. That the governments of American nations reach an agreement for the purpose of creating an office or congress of cartography and geography.

V. That proper steps and measures be taken to bring about in the American republics participating in the congress a general use of the metric system of weights and measures, in the press, in educational and scientific work, in the industries, in commerce, in transportation, and in all the activities of the different governments.

VI. Confirms the resolution recommended to the American republics by the First Pan-American Scientific Congress regarding the installation of meteorological organizations to serve as a basis for the establishment of the Pan-American meteorological service, and expresses the desire that the republics not yet possessing organized meteorological service establish the same as soon as may be practicable.

VII. That there be appointed an international Pan-American committee to study and report upon the question of establishing such a uniform gauge as will best serve the countries' interest, their international communication, and the communication between all the countries of America.

VIII. The appointment of an American committee on radio communication to assist in development of the science and art of radio communication, to the end that it may serve to convey intelligence over long distances and between ships at sea more quickly and accurately, and to bring into closer contact all of the American republics.

IX. That through the governmental agencies of the American republics a cooperative study of forest conditions and forest utilization be undertaken and that the data thereon be published.

X. That each of the American nations appoint a commission to investigate and study in their respective countries the existing laws and regulations affecting: (*a*) The administrative practise of regulating the use of water; (*b*) The adjudicating of rights pertaining to the use of surface and underground water for irrigation purposes; (*c*) The distribution, application, and use of water upon arid and irrigable land; (*d*) Methods of conservation of surface and underground waters for irrigation or industrial purposes; (*e*) And to suggest laws or regulations in the interest of general industry, navigation and commerce.

XI. That the question of the reclamation of arid lands is one that should receive the immediate and careful consideration of the several governments of the American states, so that there may be increased areas of productive land to meet the needs of their increased populations.

XII. (*a*) That each country should maintain a well-organized and competent live-stock sanitary service comprising executive officers, field inspectors and a laboratory force; (*b*) That each country should enforce live-stock sanitary laws and regulations, with the view of preventing the exportation, importation and spread within the country of any infectious, contagious or communicable diseases by means of animals, animal products, ships, cars, forage, etc.; (*c*) That each country should maintain a thorough live-stock sanitary survey to determine what communicable diseases of animals are present and the localities where they exist. This information should be furnished regularly to each of the other countries at stated periods as a routine feature; (*d*) That each country should refrain from exporting animals, animal products, forage and similar materials which are capable of conveying infectious, contagious or communicable animal diseases to the receiving country; (*e*) That each country should enforce measures to prohibit the importation of animals, animal products, forage and other materials which may convey diseases from countries where dangerous communicable diseases such as rinderpest, foot-and-mouth diseases, and contagious pleuropneumonia exist, and which have no competent live-stock sanitary service. Animals, animal products, forage and similar materials from countries maintaining a competent live-stock sanitary service may be admitted under proper restrictions, regulations and inspections, imposed by the importing country; (*f*) That each country, through its live-stock sanitary service, should endeavor to establish a complete exchange of information as to the methods followed which have proved most successful in combating animal diseases; (*g*) That members of the live-stock sanitary service of each of the American countries should meet at regular intervals to consult and inform each other regarding the measures taken for furthering cooperation in protecting the live-stock industry of the American countries.

XIII. That an American plant-protection conference be convened, the delegates thereof to be one or more technical experts from each of the several American countries, and that, as soon as practicable, a meeting of this conference be held to discuss suitable legislation, the means of establishing competent scientific bureaus, and to recommend such cooperative research work and control of plant introduction as may be advisable, and to use all reasonable efforts to secure appropriate action by the several countries.

XIV. Recommends the distribution of information regarding the agricultural production of the different countries and of the publications relating thereto.

XXVIII. (1) That a compilation according to a definite plan be made of the mining laws of the American countries, not only in their original languages, but also in English or Spanish or Portuguese translations, as the case may be, with a view to the reciprocal improvement of the laws of each individual country. (2) That the several American governments appoint a committee to consider the uniformity of mining statistics, and to make recommendations to their respective governments for the systematizing, simplifying and standardizing of such statistics.

XXIX. That all American countries inaugurate a well-considered plan of malaria eradication and control based upon the recognition of the principles that the disease is preventable to a much larger degree than has thus far been achieved, and that the education of the public in the elementary facts of malaria is of the first order of importance to the countries concerned.

XXX. That the American republics in which yellow fever prevails, or is suspected of prevailing, are urged to enact such laws for the eradication of yellow fever as will best accomplish that result. That inasmuch as yellow fever exists in some of the European colonies in America, it is desirable to invite them to adopt measures for its elimination.

XXXIV. That the American governments, deriving important revenues from the consumption of alcohol, should organize their systems of taxation so that the economic interests be subordinated to the higher interests of a social and moral order, which tend to the suppression of alcoholism.

XXXV. That it is very advisable that the different monetary systems of the American republics be studied from a scientific point of view and in connection with the experience of the various American countries, in such matters.

XXXVI. That the American republics make uniform, as far as possible, the basis and adopt a common time for the taking of census, and adopt uniform principles in commercial and demographic statistics.

In conclusion, the congress specially recommends, for execution by the present Pan-American Union or by means of any other institution in actual existence or to be established, the following propositions:

The establishment of an intellectual Pan-American union to unite the various associations of different character—technical, medical, legal, etc.—divided into sections according to the groups that may be deemed convenient, such as a university section, a library section, etc.

The details thereof are contained in the records of the congress in the form of four propositions dealing with the proposed union. The organization that may take charge of its establishment will lay broad and deep the true foundations of intellectual Pan-Americanism.

SCIENTIFIC NOTES AND NEWS

The permanent secretary of the American Association for the Advancement of Science requests us to state that in the report of the Columbus meeting reference should have been made in the account of the opening exercises to the admirable response to the address of welcome by the president of the association, Dr. W. W. Campbell, director of the Lick Observatory.

The Bruce gold medal of the Astronomical Society of the Pacific has been awarded to Dr. George Ellery Hale, director of the Mount Wilson Solar Observatory.

At the recent meeting of the American Society for Experimental Pathology in Boston, Dr. Simon Flexner was elected president, Dr. Gideon Wells vice-president, and Dr. Peyton Rous secretary for the year 1916. The Society for Experimental Pathology will hold its next meeting in New York next December, together with the other constituent organizations of the Federation of American Societies for Experimental Biology. Dr. Flexner is the chairman of the executive committee of this organization for 1916 and Dr. Rous is general secretary.

Officers of the Philosophical Society of Washington elected for 1916 are: *President,*

L. J. Briggs; *Vice-presidents,* E. Buckingham, G. K. Burgess, W. J. Humphreys, Wm. Bowie; *Secretaries,* J. A. Fleming, P. G. Agnew; *Treasurer,* R. B. Sosman; *General Committee:* The foregoing officers and the following members-at-large: H. L. Curtis, N. E. Dorsey, R. L. Faris, E. G. Fischer, D. L. Hazard, R. A. Harris, W. F. G. Swan, W. P. White, F. E. Wright and Past-presidents G. W. Littlehales and C. K. Weed.

RECENT grants from the Bache Fund of the National Academy of Sciences have been made by the Committee as follows:

No. 187 to H. H. Lane, State University of Oklahoma, $500 for the purchase of apparatus to be used in a comparative study of the embryos and young of various mammals in order to determine, by physiological experimentation and morphological observations, the correlation between structure and function in the development of the special senses.

No. 188 to H. W. Norris, Grinnell College, $100 for assistance in the analysis of the cranial nerves of Cœcilians (*Herpele* and *Dermophis*).

No. 189 to E. J. Werber, Woods Hole, $230 for assistance in experimental studies aiming at the control of defective and monstrous development: (1) The effect of toxic products of metabolism on the developing teleost egg; (2) the effect of experimentally produced diseases of parental metabolism on the offspring in mammals.

No. 190 to H. S. Jennings, Johns Hopkins University, $200 for assistance in the study of evolution in a unicellular animal multiplying by fission: heredity, variation, racial differentiation in *Difflugia.*

No. 191 to P. W. Bridgman, Harvard University, $500 for mechanical assistance in an investigation of various effects of high hydrostatic pressure, in particular the effect of pressure on electrical resistance of metals (continuation).

No. 192 to J. P. Iddings, Washington, D. C., $1,000 for apparatus and assistance in the microscopical and chemical investigation of igneous rocks, for the purpose of extending knowledge regarding petrographical provinces and their bearing on the problem of isostasy.

No. 193 to C. A. Kofoid, University of California, $500 for assistance in securing animals in the Indian jungle and in their preparation for study in research on the intestinal protozoa.

No. 194 to R. A. Daly, Harvard University, $1,000 for the purchase of a thermograph of new design for determining temperature in the deep sea.

No. 195 to R. W. Hegner, University of Michigan, $160 for assistance in the study of the history of the germ cells, especially in hermaphrodite animals in order to determine the visible changes that take place in their differentiation and the causes of these changes (continuation).

The Committee on the Bache Fund at present is constituted as follows: Ross G. Harrison, Yale University; Arthur G. Webster, Clark University, and Edwin B. Frost, chairman, University of Chicago (Williams Bay, Wisconsin).

WE learn from *Nature* that the committee appointed by the Paris Academy of Sciences to examine the requests for grants from the Bonaparte Fund make the following proposals, which have been confirmed by the academy:

3,000 francs to Auguste Lameere, professor at the University of Brussels, to enable him to continue his researches at the Roscoff Zoological Station.

4,000 francs to Charles Le Morvan, assistant astronomer at the Paris Observatory, for the publication of a systematic and photographic map of the moon.

2,000 francs to Paul Vayssière, for the continuation of his researches on the various species of cochineal insects.

3,000 francs to François de Zeltner, to contribute to the cost of a proposed expedition to the Sudanese Sahara, more particularly in the Aïr massif.

2,500 francs to Léonard Bordas, to assist him in pursuing his investigations relating to insects attacking trees and forests, and more especially species which at the present time are devastating the woods of the central plateau and west of France.

3,000 francs to Joseph Bouget, botanist at the Pic du Midi Observatory, for realizing his cultural experiments on a larger scale, with special reference to the improvement of the pastures of the Pyrenees.

3,000 francs to Henry Devaux, professor of plant physiology at Bordeaux, for the continuation of his researches on the cultivation of plants in arid or semi-desert regions.

2,000 francs to Victor Piraud, for the continuation of his studies on the fauna of Alpine lakes and torrents, particularly at high altitudes.

2,000 francs to Marc Tiffeneau, for the continu-

ation of his studies on the phenomena of molecular transposition in organic chemistry.

In conformity with authorization by the minister of justice and public instruction a small expedition was despatched from the Argentine National Observatory at Córdoba to Venezuela to observe the total eclipse of the sun on February 3. The expedition is in charge of Astronomer Chaudet and is equipped with two cameras for photographing the corona, two prismatic cameras for the flash and coronal spectrum, a small slit spectrograph and a photometer. It was expected to occupy a station in or near Tucacas.

The post of mining geologist in the ministry of agriculture and commerce of China has been offered to Dr. Warren D. Smith, professor of geology in the University of Oregon. Dr. Smith went to the university in September, 1913, from the Philippines, where he was chief of the division of mines in the bureau of science. He had been in government service in the Philippines nine and a half years.

Dr. Otto Schoebl has resigned as assistant director of the quarantine laboratory, port of New York, health officers' department, to accept a position in the Bureau of Science, Manila, P. I.

Dr. William J. Means, one of the organizers of the Ohio State University and dean of the Starling-Ohio Medical University since the merger in 1907, has resigned, to take effect June 30, on account of impaired health and age.

Professor J. H. Faull, of Toronto University, recently spent nearly two weeks at the New York Botanical Garden in a study of herbarium material of the Polyporaceæ, with special reference to collections made in Ontario.

Professor H. V. Tartar, whose publications on the results of his research investigations with arsenical sprays have materially modified certain spraying practises, has been granted a two-year leave of absence as head of the Oregon Experiment Station Department of Chemistry, to pursue research work at some of the leading eastern universities.

Professor J. E. Kraus, research specialist in horticulture at the Oregon Agricultural College, has been given a two-year leave of absence to continue studies in eastern universities. He will first spend some time with the U. S. Bureau of Plant Industry investigating certain pollination problems at Miami, Florida, after which he will begin his investigational studies at Chicago.

Dr. Charles S. Pancoast, Philadelphia, who went to Vienna in December, 1914, is now in charge of a 4,000-bed hospital at Munkacz in the Carpathians.

Dr. Aylmer May, principal medical officer of northern Rhodesia, has been selected by the British war office to undertake research work on the western front in connection with wound infection.

Dr. H. M. Woodcock, assistant to the late Professor E. A. Minchin, has been appointed acting head of the department of protozoology at the Lister Institute, London.

The Minnesota and Wisconsin Chapters of the Society of Sigma Xi have established an annual exchange lectureship. For the present year President Charles R. Van Hise will represent Wisconsin in a lecture at the University of Minnesota on March 17. Professor E. M. Freeman will be the Minnesota representative in a lecture at the University of Wisconsin at some date during the second semester.

Professor William T. Councilman, of Harvard University, will lecture before the Experimental Medicine Section of the Cleveland Academy of Medicine on February 11. His subject is "Glioma."

The sixth lecture of the Harvey Society series delivered at the New York Academy of Medicine, on February 5, was by Dr. Hideyo Noguchi, of the Rockefeller Institute for Medical Research, on "Spirochetes."

The Guthrie lecture of the Physical Society was delivered at the Imperial College of Science on January 28, by Mr. W. B. Hardy, on the subject "Some Problems of Living Matter."

The Prussian ministry of public instruction has ordered the erection of a bust of von

Behring in the Marburg Institute for Hygiene in memory of the twenty-fifth anniversary of Behring's publication of his work on serum therapy.

ON recommendation of the council of the Biological Society of Washington the following resolution drawn up by L. O. Howard, Frederick V. Coville and Paul Bartsch has been adopted:

WHEREAS, Dr. George M. Sternberg, former Surgeon General of the U. S. Army, a distinguished worker in the biological sciences as applied to medicine, long time an active member of the Biological Society of Washington and its president during the years 1895 and 1896, has passed from this life, therefore be it

Resolved, That the Biological Society of Washington keenly regrets his death and offers its warmest sympathy to Mrs. Sternberg, and will always be grateful to his memory for the important part which he took in the affairs and discussions of the Society and for the distinction which his eminent name adds to its list of past-presidents.

DR. THOMAS H. RUSSELL, professor of clinical surgery in the Yale Medical School and surgeon at the New Haven General Hospital, died on February 3, at the age of sixty-three years.

DR. OSWALD KÜLPE, professor of philosophy and psychology at Munich, has died at the age of fifty-three years.

THE death is announced of Dr. Georg Grüpler, who in his laboratories at Leipzig and Dresden carried on physiological and bacteriological research in connection with the proteins, the enzymes and bacteriological stains.

THE *Medizinische Klinik* of December 26 as quoted in the *Journal* of the American Medical Association gives figures showing that the names of 1,084 physicians have appeared on the 400 casualty lists that had been published by that date in Germany. The list includes 37 civilian physicians, 377 active medical officers, 373 of the reserve force and 287 assistant medical officers. Of this total, 361 have been killed, 142 severely and 388 less severely wounded, 102 have been taken prisoners, and 90 are missing.

THE University of Colorado Mountain Laboratory, which is now in its eighth year of operation, will hold a six-weeks' session, beginning on June 26, 1916. Courses in zoology are in charge of Professor Frank Smith, of the University of Illinois; those in botany will be given by Professor Francis Ramaley, of the University of Colorado, at Boulder. The mountain laboratory does not duplicate work of the regular college year, but offers courses primarily concerned with ecology and distribution. Most of those who attend are graduate students and high-school and college instructors.

UNIVERSITY AND EDUCATIONAL NEWS

CONTRACTS have been let recently by the board of directors of the Texas Agricultural and Mechanical College for a new hospital for which the legislature recently appropriated $50,000, and a new dairy barn to be erected at a cost of $10,000. President Bizzell has announced that plans and specifications are about completed for the new Animal Husbandry Building to cost $40,000 and a new hog cholera serum plant, for which $15,000 are now available. Professor R. Adelsperger, head of the department of architecture and architectural engineering at the college, will begin immediately on plans and specifications for the new college auditorium to be erected at a cost of $100,000 and a new Veterinary Medicine Building to cost $100,000. The funds for these two buildings will not be available until September 1, 1916.

A NEW forestry building costing $40,000 has been authorized by the board of regents and will be erected on the Oregon Agricultural College campus during the coming spring and summer. It will be a brick structure, three stories high and 80 feet wide by 140 feet long. A large laboratory for logging-engineering will be located on the first floor, with smaller laboratories for the manufacture of wood products. The second and third floors will be occupied by offices, classrooms and smaller experimental laboratories. The building will be ready for occupancy at the opening of the next college year, September, 1916.

The committee of the board of trustees of Cornell University on faculty participation in university government has recommended that three representatives of the faculty selected by ballot shall sit at meetings of the board with full powers except that of voting, and that each faculty shall select committees to meet with the general administrative committee of trustees. The board has approved in principle the second recommendation and has referred the whole question back to the committee for further conference with the faculty committee.

Dr. Willard C. Fisher, whose enforced resignation from Wesleyan University will be remembered, has been appointed acting professor of economics at New York University.

At Princeton University, E. Newton Harvey, Ph.D., has been promoted to an assistant professorship of physiology.

Professor William Stern, of Breslau, has received a call from Hamburg to fill the chair of philosophy and psychology vacant by the death of Professor Ernst Meumann.

DISCUSSION AND CORRESPONDENCE

PARASITES OF THE MUSKRAT

In the *Journal of Parasitology,* Vol. 2, No. 1, p. 46, Linton describes cestode cysts found in the liver and omentum of a muskrat found near Washington, Pa., in 1884. On the basis of the size and shape of the hooks and the appearance of the bladderworm Linton considers these to be *Cysticercus fasciolaris,* the larval stage of *Tænia crassicollis,* a tapeworm which is frequently found in the intestine of the cat.

The finding of *Cysticercus fasciolaris* in the muskrat has been previously reported by Stiles & Hassall, 1894, in "A Preliminary Catalogue of the Parasites Contained in the Collections of the United States Bureau of Animal Industry, United States Army Medical Museum, Biological Department of the University of Pennsylvania (Coll. Leidy) and in Coll. Stiles and Coll. Hassall."

Dr. Allen J. Smith, of the University of Pennsylvania, has written me that he has in his possession "a specimen of liver of the muskrat which is tremendously enlarged and riddled with *Cysticercus fasciolaris.*" This muskrat was trapped in the winter of 1904–05 near Philadelphia.

Among fifty muskrats examined from Nebraska and Minnesota in no case have we found the liver infected with any kind of parasite.

We have found in the intestine of one muskrat, shot at Lake Chisago, Minnesota, in August, 1915, several hundred minute monostome trematodes which represent a new species.

These two parasites should be added to the list given by us for the muskrat in Science, N.S., Vol. 42, p. 570, and the *Journal of Parasitology,* 1915, Vol. 1, pp. 184–197.

Franklin D. Barker
The University of Nebraska

THE USE OF THE INJECTION PROCESS IN CLASS-WORK IN ZOOLOGY

It is often difficult or impossible in a laboratory class in zoology to demonstrate pathways of fluids or food in certain animals, in other than a purely structural way. Blood vessels are injected and studied as so many colored strings or tubes, and cavities and ducts are explored with a probe, leaving much to the imagination. During the summer course in zoology at the University of Cincinnati, we have made extensive use of the injection method for studying the mechanics of these structures, and their condition during operation. A glass tube is drawn out into a point of any desired size, and attached to a rubber hand bulb, either directly or by a rubber tube. This apparatus, including a bunsen burner and cutting file, is simple and cheap enough to be included as a part of each student's equipment. The injecting fluid used is usually India ink or Prussian blue. The following example will show how the method is used in studying the circulation of a freshly killed crayfish.

The animal is killed by chloroform or ether, and the carapace dissected off. The student then exposes the heart, being careful not to cut any of the surrounding tissue. A fine-pointed glass cannula is now inserted through a hole made with the point of the glass injecting

needle, or through a slit made with a scissors. Under favorable conditions, the point may be fitted into one of the ostia. The India ink is now slowly injected, and the progress of the ink watched through the transparent vessel walls. In this way, a student can realize what is meant by blood pressure, peripheral resistance of capillaries, physiological pathways open at the time of death, delicacy of capillary beds, as well as the course of the main blood vessels. There is an added advantage, in that one is able to "feel" the resistance of the vessels and capillaries, as well as to see the fluid as it passes through. The addition of a mercury manometer between the bulb and the glass tube may be of use in making quantitative or comparative studies. The advancing stream of black is carefully watched and the order in which the vessels are filled is noted. A very good idea of the relative strengths of the vessels is obtained by watching for extravasations. After these points have been observed, the injection still remains and can be studied, considerable dissection being possible without leakage. In case the ink runs on to the tissues, it can be washed off under the hydrant. The brilliant contrast of black and white is of course obvious.

A particularly instructive study can be made by injecting the venous system of the crayfish. The carapace is removed from a freshly killed specimen, and the gills exposed. The ink is then slowly injected into the ventral sinus of the abdomen. The advancing stream can be followed from the different parts of the body (well seen in the transparent joints) to the gills, through them, back to the body wall, and to the pericardial sinus. The picture seen on clearing one of the gills in glycerine has a new interest to the student, he having watched and controlled the process of filling them.

This method, besides presenting many anatomical structures from a physiological point of view, has a wide range of application. A truer, safer and more graphic picture is obtained by injecting a duct or opening, than could be secured by probing it. This is of value in some animals in tracing the bile and pancreatic ducts, as well as those of other glands. It has been successfully applied in some cases to formalin material. Thus the stomach and radial canals of *Gonionemus medusa* can be demonstrated very well, as can also the pharynx of *Amphioxus* and its relation to the atrial cavity. Formalin specimens of tapeworm show the longitudinal and connecting excretory canals very clearly. The living earthworm is very resistant to injections of the blood vessels, a point easily correlated with the fact that on cutting the worm, contraction of the vessels prevents bleeding to death. In the grasshopper, the connections between the alimentary canal and gastric ceca can be well shown by injection per os. In some cases water serves the purpose of the ink, as in studying the path of the water in the nasal aperture of the dogfish, or the change of the relations of the parts of the digestive tract when full and empty, or the resistance their inner folds presents to the passage of the food.

In these injections it should be borne in mind that the process is the part desired, not necessarily the finished product. Furthermore, the student should realize that the condition of the preserved specimen merely represents one set of conditions in the life of the animal, and the injection should therefore be considered as showing graphically the physiological condition of the animal at the time of death only, with such subsequent changes as naturally follow. This is well shown by the different amounts of ink flowing into each vessel, and the ease with which they are filled. The details noted above, while probably including points now in use in many laboratories, are given here, as we have found that the use of this technique has given the elementary student a simple means of studying, in the animals dissected in the laboratory, some of the more fundamental problems of the dynamics of organs.

RAPHAEL ISAACS
UNIVERSITY OF CINCINNATI

THE POISONOUS CHARACTER OF ROSE CHAFERS

I WAS particularly interested in the article on this subject in SCIENCE, January 28, 1916,

because for many years past there has occurred a serious loss among the brook trout (and I think also the rainbow trout) of Pine Creek, at Long Pine, Nebraska. They have floated down stream dead, in large numbers, and stuffed with live rose chafers. The theory to account for this has been the same as stated by the above writer, namely, mechanical, though no real mechanical damage has been observed. I have no doubt of the poisonous character of the beetle, and add this note to extend the knowledge of its effects on a very different order of life. The chafers, it should be said, feed on the willows, chiefly *Salix fluviatilis*, that overhang the stream, sometimes stripping them bare.

J. M. Bates
Red Cloud, Nebraska

SCIENTIFIC BOOKS

British Antarctic (Terra Nova) Expedition, 1910. Zoology, Vol. I., No. 2, *Natural History of the Adelie Penguin*, by G. Murray Levick, M.D., R.N.; No. 3, *Cetacea*, by D. G. Lillie, M.A.; Vol. II., No. 2, *Oligochæta*, by H. A. Baylis, B.A.; No. 3, *Parasitic Worms*, by R. T. Leiper, D.Sc. and E. L. Atkinson, M.D., R.N.; No. 4, *Mollusca*, Pt. 1, by Edgar A. Smith, I.S.O.; No. 5, *Nemertinea*, by H. A. Baylis, B.A.; British Museum Nat. History, 1915, 4° with many plates and text-figures.

Notwithstanding financial stringency caused by the war, and the absence of many of the younger men of science in the hospital or the trenches, British scientific institutions have been able, as a rule, to continue publication though in restricted measure. The various papers based on material collected by the *Terra Nova* expedition have been coming out separately at intervals during 1915, without reference to the order in which they are intended finally to be bound up.

Dr. Levick's account of the habits of the Adelie penguin, illustrated by twenty plates, is most interesting and some of their proceedings, especially their habit of unanimous "drilling" in large masses like a regiment of well-trained soldiers, are inexplicable on any hypothesis.

Lillie's account of the whales relates chiefly to subantarctic species mostly observed at whaling stations in New Zealand. He is disposed to regard several of the species, especially the humpback (*Megaptera nodosa* Bonnaterre), as identical with boreal species. However the coloration and proportions as figured differ markedly from the north Pacific species (*M. versabilis* Cope) and the species of *Cyamus* infesting them are distinct. He indulges in some speculations in regard to what the whalers call the "high-finned killer," individuals with a higher dorsal fin than the others of the same school, but in the north Pacific there is always at least one of these with every school of killer whales and there is little doubt that these individuals are the old parents of the family group which forms the "school."

Baylis describes a new species of *Oligocheta* found in the gill-chamber of a land crab (*Geocarcinus lagostoma* M. Edw.) collected at S. Trinidad Island in the South Atlantic. This is the second species known to inhabit such a *situs*, and does not appear to have been materially modified by its parasitic habit. Two new Nemerteans are described from the Antarctic Sea, a *Baseodiscus* and a *Lineus*, and two known species of *Amphiporus* were also obtained, while three other species were obtained in New Zealand waters.

The parasitic worms described by Leiper were chiefly obtained from seals and fishes, the birds proving almost free from parasites. A free living Nematode was dredged in McMurdo Sound in 250 fathoms. The species are well illustrated and the paper concludes with a summary of the species collected by previous Antarctic expeditions.

The Prosobranch, Scaphopod and Pelecypod mollusca are described with his usual care by Edgar A. Smith and illustrated by two excellent plates. Fifty-eight species are enumerated from the Antarctic region of which twelve are new.

The expeditions of the *Discovery* and *Southern Cross* had previously obtained a large proportion of the fauna of the region visited by the *Terra Nova*. Nothing very striking appears among the novelties except one or two

odd forms referred to *Trichotropis*. A new species of *Neoconcha* has a strong resemblance to *Torellia*. *Modiolaria lateralis* Say, originally described from the Florida coast, was obtained from South Trinidad Island, 700 miles off the coast of Brazil in the South Atlantic.

WM. H. DALL

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

(VOLUME 2, NUMBER 1)

THE first number of volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *A Possible Origin for Some Spiral Nebulæ:* G. F. BECKER, United States Geological Survey, Washington.

It is suggested that nebulæ may be developed from nebulous streamers or "bacula." Comparison of the theoretical shape of the nebulæ at certain stages of their development with the Whirlpool nebula is not unfavorable to the hypothesis.

2. *A Peculiar Clay from near the City of Mexico:* E. W. HILGARD, University of California.

The analysis shows that the predominant base is magnesia. A peculiarity of the clay is its exceptionally high absorptive power for water.

3. *Studies of Magnitude in Star Clusters, I. On the Absorption of Light in Space:* HARLOW SHAPLEY, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The examination of the Hercules cluster indicates the conclusion that the selective extinction of light in space is entirely inappreciable and that probably the non-selective absorption in space is also negligible.

4. *Studies of Magnitudes in Star Clusters, II. On the Sequence of Spectral Types in Stellar Evolution:* HARLOW SHAPLEY, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The giant second-type stars are present in large numbers in the globular clusters. The results offer difficulties for the conventional scheme of evolution of spectral types, but the difficulties are not so severe for Russell's hypothesis.

5. *Experimental Evidence for the Essential Identity of the Selective and Normal Photo-Electric Effects:* R. A. MILLIKAN and W. H. SOUDER, Ryerson Physical Laboratory, University of Chicago.

Photo-electric phenomena are not in general conditioned by the presence of a gas. All distinctions between the normal and selective effects in lithium have disappeared.

6. *Concomitant Changes in Terrestrial Magnetism and Solar Radiation:* L. A. BAUER, Department of Terrestrial Magnetism, Carnegie Institution of Washington.

Changes in the earth's magnetism of appreciable amount are found associated with changes in solar radiation. Decreased solar constant is accompanied by increased magnetic constant. Various minor but important correlations are established.

7. *Submarine Solution of Limestone in Relation to the Murray-Agassiz Theory of Coral Atolls:* A. G. MAYER, Department of Marine Biology, Carnegie Institution of Washington.

By exposing pieces of shell of the mollusc *Cassis* to solution in sea-water for a year under various conditions, it is shown that the rate of solution is too slow to be favorable to the theory that the solvent action of sea-water for limestone is a primary factor in deepening and widening the lagoons of coral atolls.

8. *The Archegonium and Sporophyte of Treubia Insignis Goebel:* D. H. CAMPBELL, Department of Botany, Stanford University.

Treubia is probably on the whole nearer the leafy liverworts than is any other anacrogynous genus.

9. *Brief Notes on Recent Anthropological Explorations under the Auspices of the Smithsonian Institution and the U. S. National Museum:* ALEŠ HRDLIČKA, Division of Physical Anthropology, U. S. National Museum.

The topics treated are: Search for Neolithic Human Remains in Southwestern Russia;

Explorations in the Birusa Caves and Rock Shelters on the Yenisei River, Siberia; Development of the Child among the Negrito, the African Negro, the Eskimo, and Native Siberians.

10. *A Theory of Nerve-Conduction:* A. G. Mayer, Department of Marine Biology, Carnegie Institution of Washington.

The theory of nerve-conduction is based upon the phenomena of adsorption. The results lend no support to the theory that the velocity of propagation of nerve impulse is that of a shear in the substance of the nerve.

11. *Zuñi Culture Sequences:* A. L. Kroeber, Museum of the Affiliated Colleges, San Francisco.

The author gathered a large number of potsherds in and near Zuñi, and is able to make a tentative chronological classification of the objects.

12. *The Numerical Results of Diverse Systems of Breeding:* H. S. Jennings, Zoological Laboratory, Johns Hopkins University.

The proportions of the population which are found after n generations arising from continued breeding in various ways are tabulated for 24 different methods of mating.

13. *On the Effects of Feeding Pituitary Body (Anterior Lobe) Substance, and Corpus Luteum Substance to Growing Chicks:* Raymond Pearl, Biological Laboratory, Maine Agricultural Experiment Station.

The commencement of the laying period in pullets is neither retarded nor accelerated by feeding pituitary and corpus substance, but the body growth is retarded.

14. *A Preliminary Report on Further Experiments in Inheritance and Determination of Sex:* Richard Goldschmidt, Osborn Zoological Laboratory, Yale University.

The article states a number of new results found by the author in continuing his earlier work on the interbreeding of gypsy moths. Every gradation of intersexualism from a normal female to a normal male, and from a male three-fourths of the way toward the female has been obtained.

15. *On the Degree of Inbreeding which exists in American Jersey Cattle:* Raymond Pearl and S. W. Patterson, Biological Laboratory, Maine Agricultural Experiment Station.

American Jersey cattle are about one half as intensely inbred when eight generations are taken into account as would be the case if continued brother $\times$ sister breeding had been followed. In general, Register of Merit animals are *less* intensely inbred than the ordinary population.

16. *Upper Limit of the Degree of Transitivity of a Substitution Group:* G. A. Miller, Department of Mathematics, University of Illinois.

The degree of transitivity of a substitution group of degree n which does not include the alternating group of this degree is always less than $\frac{5}{2}\sqrt{n} - 1$.

17. *The Extension of the Montana Phosphate Deposits Northward into Canada:* F. D. Adams and W. J. Dick, Commission of Conservation of Canada.

An account of the explorations carried out to ascertain whether phosphate-bearing rocks extend northward from Utah, Idaho, and Montana into Canada. In some places such an extension has been found.

Edwin Bidwell Wilson
Mass. Inst. of Tech.

NOTES ON METEOROLOGY AND CLIMATOLOGY

SNOWFALL AND SNOW COVER

The destructive snowstorm of December 13, 1915, in the vicinity of New York showed strikingly the ocean control on the depth of snowfall. While the precipitation (rain and melted snow) was heavy everywhere, the depth of snowfall, according to press reports, ranged from little or nothing in eastern Massachusetts to one foot between New York and New Haven and two feet near Albany. The warmth of the ocean effectively prevented snowfall where the winds blew off the water and made it sticky and dense near the coast, even though the surface wind was from the north. Not until February or March does heavy snowfall usually occur with winds from the ocean. A

discussion with maps of the snowfall of the eastern United States was published by C. F. Brooks in the *Monthly Weather Review*, June, 1914, and January, 1915.

Snowstorms of the eastern United States are difficult to forecast, because a sleet or ice storm frequently occurs instead. Professor H. C. Frankenfield, of the Weather Bureau, has recently made a study of the temperatures preceding sleet and snow storms.[1] Steep temperature gradients northward, and high temperatures over the Gulf and south Atlantic states are necessary for sleet formation and usually absent before and during heavy snows.

The heavy snowfall problem in mountains of the west is discussed by A. H. Palmer in a well-illustrated paper, "The Region of Greatest Snowfall in the United States."[2]

Tamarack, and Summit, California, have the greatest observed snowfall in the United States.

Station	County	Watershed	Altitude (Feet)	Length of Record (Years)	Annual Snowfall (Inches)			Total Rain and Melted Snow (Inches)
					Average	Max.	Min.	
Tamarack.....	Alpine	San Joaquin	8,000	8	521	757	.....	57.5
Summit.....	Placer	Sacramento	7,017	44	420	{783 776	154	48.1

During heavy snowfall the wind is usually relatively light, in marked contrast to the windy snowstorms of the east. The pressure of the snow on any raised objects becomes very great. A fence made of two-inch boiler flues has been bent; the snow sheds, even where built of twelve- by fourteen-inch timbers occasionally collapse, and the gables of the houses are steep to prevent similar crushing.[3] For thirty-two miles, from Blue Canyon to Truckee, expensive snow sheds are required to protect the Southern Pacific tracks from the snowfall and avalanches.

DEPTH OF SNOW ON GROUND (9-YEAR AVERAGE) (INCHES)

	Dec. 1	Jan. 1	Feb. 1	Mar. 1	Mar. 15	Mar. 31
T	19	62	165	183	194	192
S	9	44	122	127	140	118

Mountain snowfall is of immense value for water power and for irrigation; and to some extent this value is controlled by the rate of melting. Messrs. A. J. Jaenicke and M. H. Foerster have written an article on "The Influence of a Western Yellow Pine Forest on the Accumulation and Melting of Snow."[4] Five years of records near Flagstaff, Arizona, indicate that the snowfall in the forest and adjacent grass and farm land park is same; but that the rate of melting is different. In the park the minimum temperatures are lower and the maxima are higher than those in the forest. Thus the soil in the park is generally frozen before the winter snow cover is established, while in the forest the soil may freeze only in a few spots. Any water from melting snow in winter forms an ice layer at the base of the snow cover in the park, but sinks into the ground in the forest. In winter on account of the generally higher temperatures and the heating of the local bare spots and trees, the snow melts more rapidly in the forest than in the park. In spring, on the contrary, the formation of slush, the strong sunshine, and higher wind velocity in the park cause the snow to melt a week, or even more than two weeks, before the last drifts of snow in the forest. The frozen soil and the basal ice layer in the park allow the water to run off very rapidly, while only occasionally is there any surface run-off in the forest. The value of open forest for water conservation is evident.

[1] "Sleet and Ice Storms in the United States," Second Pan-American Scientific Congress.

[2] *Mo. Weather Rev.*, May, 1915. See map of the snowfall of the United States by C. F. Brooks, *Quar. Jour. Roy. Meteorological Soc.*, April, 1913.

[3] Note the destructive effect of the heavy snowfall at Flagstaff, Arizona, December 29–31, 1915.

[4] *Mo. Weather Rev.*, March, 1915.

In order to estimate the water from mountain snowfall which will become available in summer, snow surveys are made every spring in the mountains of the west. Type watersheds are surveyed; and the snow is estimated on adjacent ones. The use of a snow sampler gives best results. Several sections of tubing of small diameter are used to cut vertical snow cylinders. This is done at a great many points; and the water content of the snow determined by weight.[5]

WEST INDIA HURRICANES

Two very intense tropical cyclones visited the gulf coast in August and September, 1915, the first taking its greatest toll of life in Texas and the second in Louisiana. The 1915 Galveston storm made its appearance the morning of August 10 between Dominica and the Windward Islands of Barbados. The storm on passing Haiti, Jamaica and Cape San Antonio, Cuba, did immense damage to the banana and sugar crops; and sank one large steamer. In Texas the loss of life was 275; and in the severe floods occasioned as far as the Ohio Valley 30 were drowned. The cyclone passed out the St. Lawrence Valley August 23. The lowest pressure reading (reduced to sea level) was 28.20 inches (955.6 kb. or mb.) at Houston; the highest wind velocity for five minutes was 93 miles per hour, at Galveston. While the high tide at Galveston was about the same as in 1900, less damage resulted owing to the protection afforded by the sea wall and the elevation of part of the city.

The land winds on the coast of southern Texas brought on the highest temperatures ever recorded at Brownsville (104° F.), and Corpus Christi (100° F.). In Texas the central calm of the cyclone was about 6 miles in diameter, and its forward movement was 15 miles per hour.[6]

One of the most thorough studies ever made of a tropical cyclone was that conducted by Dr. I. M. Cline of the Weather Bureau at New Orleans, September 29, 1915.[7] The storm originated near 64° W. longitude in the Caribbean Sea September 23 and passed over New Orleans six day later. The sea level pressure minimum of 28.11 inches (952.5 kb. or mb.) at New Orleans established a new low record for the United States; and the winds attained tremendous velocities. At New Orleans the maximum for 5 minues was 86 miles per hour, and for half a minute, 130. At Burrwood, Louisiana, where the wind had an unobstructed sweep, the average velocity for 3 hours was 103 miles per hour, reaching 116 for 20 minutes, 124 for 5 minutes, and for about half a minute the rate of 140 miles per hour. While there may be doubt as to the accuracy of the cup anemometer, these figures give some quantitative measurement of the tremendous violence of the wind. The wind is described as coming in a series of puffs of a few seconds' duration. The wind did not veer gradually but changed suddenly from one point to the next; and just before each change the rainfall was intense. So violent was the wind that probably no house in New Orleans escaped damage. The total rainfall at New Orleans was 8.20 inches, but was as high as 14.43 in Washington County. Fifty miles west of the center the rainfall was negligible. The pressure gradient was 1 inch (33.9 kb. or mb.) in 50 miles. The central calm was about 8 miles and the whole storm (pressure below 29.50 (999.3 kb. or mb.)) 250–300 miles in diameter; and it progressed at about 12 miles an hour. The high tide overtopped the levees south of New Orleans and on the north overflowed from Lake Ponchartrain into the western part of the city. The loss of life was probably 275, and of property $13,000,000, of which a third was in New Orleans. The westerly course of both hurricanes was due apparently to the presence of high pressure areas in the east central United States. The relatively small loss of life in two such intense hurricanes is due largely to the ample warnings given by the United States Weather Bureau.

The weather immediately preceding the formation of a West India hurricane is usually hot, damp and calm. The region of origin is

[5] Professor J. E. Church, University of Nevada, Second Pan-American Scientific Congress.

[6] See *Mo. Weather Review*, August, 1915.

[7] See *Mo. Weather Rev.*, September, 1915.

generally in the west early and in the east in the middle of the season. According to Sr. J. C. Millas (Second Pan-American Scientific Congress) the original impulse which sets the air in rotation may come from winds at the level of the intermediate clouds. Thus the cyclones are probably largely convectional in origin but to some extent dynamical.

CLIMATIC SUBDIVISIONS OF THE UNITED STATES[8]

PROFESSOR R. DEC. WARD, after treating earlier and present climate subdivisions of the United States, proposes a new scheme based on the following principles:

> . . . the subdivisions should be chosen because of their special relations to cyclonic and anticyclonic tracks and movement; to local and characteristic weather distribution around lows and highs; to cyclonic and anticyclonic winds; and because of general similarity of weather types over each province. Finally, the districts should, as far as possible, be the same as those which have been officially adopted in the publication of the meteorological and climatic data of the region.

He makes eight provinces. The Eastern Province includes all the eastern United States except for the Gulf Province, a strip along the southern coasts extending inland about 200 miles from the Gulf of Mexico. The two Plains provinces have their eastern boundary roughly set at the 100th meridian—more exactly on the 2,000-foot contour. The two Plateau provinces begin at the main crest of the Rockies and the two Pacific provinces occupy the region west of the crests of the Sierra Nevadas and Cascades. The line dividing the northern from the southern Pacific, Plateau and Plains provinces follows in general the southern boundaries of Oregon, Idaho, Wyoming and Nebraska. These serviceable subdivisions not only follow Professor Ward's specifications, but also can be easily remembered.

NOTES

THE *Monthly Weather Review* under the acting editorship of Professor Cleveland Abbe, Jr., has become a comprehensive meteorological magazine international in scope. It contains in addition to direct meteorological contributions from Americans and foreigners many reprints and abstracts of important meteorological papers which have appeared elsewhere. The Weather Bureau library under the direction of Professor C. F. Talman contributes not only its monthly list of publications received and of papers bearing on meteorology, but also notes of general interest.

"A LIST of Meteorological Isograms," is the title of one such note by Professor Talman.[9]

> The term "Isogram" was suggested by Francis Galton in 1889 as a convenient generic designation for lines, on a chart or diagram indicating equality of some physical condition or quantity. . . . The largest number of those to which particular names have been assigned belong to meteorology.

The list of 90 such isograms includes the author of each term and the earliest instance of its use, so far as this information could be obtained by the compiler. Most of the terms are rarely used.

MISS E. BUYNITZKY, of the library, has contributed a "Tentative Classification for Meteorological Literature."[10] This is based on schedule F of the International Catalogue of Scientific Literature, but in general form is like the Dewey decimal system. The main divisions are as follows:

00 General Works.
10 Observatories. Methods of observation.
20 Instruments.
30 Physics of the atmosphere. Cosmical relations. Aerology.
40 Pressure.
50 Temperature. Radiation.
60 Atmospheric moisture.
70 Circulation of the atmosphere.
80 Atmospheric electricity.
90 Climate and weather.

There are 81 main heads and 71 subheads; and it is easy to add more. A few minor rearrange-

[8] *Bulletin of the Am. Geog. Soc.*, September, 1915, pp. 672–680. Condensed in *Mo. Weather Rev.*, September, 1915, pp. 467–468.

[9] *Mo. Weather Rev.*, April, 1915, pp. 195–198.

[10] *Mo. Weather Rev.*, September, 1915, pp. 362–364.

ments might be made to advantage; for instance, ice storms should be associated with sleet instead of with dew and frost; and percolation perhaps belongs with the relations of precipitation and vegetation to water supply and stream flow, rather than to the section of atmospheric precipitation. This classification is less complete, but more easily remembered than the International; and, being more recent than either the International or the Dewey systems, it meets in a satisfactory way the general requirements of modern meteorological literature.

Mr. Robert Seyboth has compiled a valuable list of the "Serial Numbers of Weather Bureau Publications."[11] The numbers begin with 60 in 1895 and end with 560, the *Monthly Weather Review* for July, 1915. The list embraces the vast majority of Weather Bureau publications, and, in addition, the important unnumbered publications are mentioned.

Professor A. J. Herbertson died July 30, 1915, at the age of 50 years. He is noted in meteorology particularly for his contribution, "The Distribution of Rainfall Over the Land," compiled for the Royal Geographical Society in 1900, and for his editorship of the Oxford Wall Maps.

Mr. Walter G. Davis, director of the Oficina Meteorologica Argentina for more than 30 years, has retired on a pension. Mr. George Wiggin, a native of New Hampshire, for 21 years assistant director, is now acting director.

Charles F. Brooks
Yale University,
January 3, 1915

SPECIAL ARTICLES

THE DEVELOPMENT OF THE PHYLLOXERA VASATRIX LEAF GALL

In Bulletin 209, recently issued by the United States Department of Agriculture, entitled "Testing Grape Varieties in the Vinifera Regions of the United States," Husmann makes the following statements, p. 12:

> The number of swellings, nodosities and tuberosities from insect punctures and the rotting of the root occasioned by them progress more or less rapidly and deeply in accordance with the texture and character of the root attacked. The weakening and ultimate death of the vine are determined by the extent of the punctures and the progress of the rot upon the roots.

Although Cook suggested that puncturing may be the stimulus for the gall production occasioned by the aphids, no evidence has ever been presented to confirm this theory. To the contrary, after intensive study of the grape-vine leaf gall produced by this insect, the writer has gathered evidence showing that so little puncturing is done by the insect that, as a gall-producing stimulus traumatic puncturing may be regarded as playing a very minor part. Histological sections of leaves attacked by *Phylloxera* readily reveal the actual puncturing done by the insect. This manifests itself in the broken-up condition of the epidermal and mesophyll cells through which the proboscis has passed. In a considerable number of slides, microscopic examination shows the proboscis itself passing through the punctured and broken-up cells. The writer has never found more than two or three epidermal cells and as many mesophyll cells thus ruptured. So slight a disturbance can not be looked upon as the main cause of such large hyperplastic growths as are produced on the leaves of the vine or on the roots of the vine. This view is substantiated by Cornu's excellent work upon the root swellings induced by the attacks of this insect.

The one thing that is definitely certain about the work of *Phylloxera* is the fact that it obtains its food by means of a sucking action. This action usually continues for about 12 to 15 days at one particular point on the leaf, and around this point, which may be called the sucking center, the gall develops. During this time the insect has obtained enough food to enable it to sustain itself, to increase its bulk considerably, and to produce several hundred eggs. The withdrawal of so much food at one point from tender growing leaves, the subsequent changes in tension and pressure at this point, and certain structural peculiarities of the gall itself, all suggest the

[11] *Mo. Weather Rev.*, July, 1915, pp. 346–350.

sucking action as the initial stimulus for gall production.

HARRY R. ROSEN
U. S. NATIONAL MUSEUM

THE QUARTER-CENTENNIAL ANNIVERSARY OF THE OHIO ACADEMY OF SCIENCES

THE twenty-fifth annual meeting of the Ohio Academy of Science was held at the Ohio State University, Columbus, on Friday and Saturday, November 26 and 27, 1915, under the presidency of Professor J. Warren Smith, of Columbus.

Owing to the anniversary character of the meeting the usual program of volunteer papers was replaced by a series of invited addresses, as follows:

Presidential Address, "Agricultural Meteorology," Professor J. Warren Smith, United States Weather Bureau, Columbus.

"Applied Meteorology and the Work of the Weather Bureau," Dr. Charles F. Marvin, Chief United States Weather Bureau, Washington, D. C.

"The Relation of the Academy to the State and to the People of the State," Dr. T. C. Mendenhall, Ravenna.

"Historical Sketch of the Ohio Academy of Science," Professor William R. Lazenby, Ohio State University, Columbus.

Reviews of Scientific Progress in the Quarter Century:

"Geology," Professor Frank Carney, Denison University, Granville.

"Botany," Professor Bruce Fink, Miami University, Oxford.

"Physics," Professor Frank P. Whitman, Western Reserve University, Cleveland.

"Zoology," Professor Edward L. Rice, Ohio Wesleyan University, Delaware.

"Chemistry," Professor William McPherson, Ohio State University, Columbus.

"Archeology," Professor G. Frederick Wright, Oberlin College, Oberlin.

At the supper, held on Friday evening at the Ohio Union, short addresses were given by visiting delegates from other scientific societies. Governor Willis had expected to be present and to speak, but was unavoidably prevented at the last moment.

Notice was received of the appointment of the following delegates; those marked with the asterisk were present at the meeting.

American Association for the Advancement of Science,
*Professor L. O. Howard, Washington, D. C.
Boston Society of Natural History,
*Professor Frederick C. Waite, Cleveland, O.
Chicago Academy of Science,
Dr. Frank C. Baker, Chicago, Ill.
Indiana Academy of Science,
*Dr. D. W. Dennis, Richmond, Ind.
Mr. E. B. Williamson, Bluffton, Ind.
Iowa Academy of Science,
*Professor Herbert Osborn, Columbus, O.
Dr. Charles R. Keyes, Des Moines, Ia.
New York Academy of Science,
Mr. Emerson McMillin, New York City.
Professor H. P. Cushing, Cleveland, O.
Academy of Natural Sciences of Philadelphia,
Dr. Howard Ayers, Cincinnati, O.
Washington Academy of Sciences,
*Professor Dayton C. Miller, Cleveland, O.
*Dr. Charles F. Marvin, Washington, D. C.
Cincinnati Section of the American Chemical Society,
Dr. Lauder W. Jones, Cincinnati, O.
Dr. Alfred Springer, Cincinnati, O.
Cincinnati Society of Natural History,
Dr. DeLisle Stewart, Cincinnati, O.
Columbus Audubon Society,
*Professor J. C. Hambleton, Columbus, O.
Miss Lucy Stone, Columbus, O.
Denison Scientific Association,
*Dr. George Fitch McKibben, Granville, O.
*Mr. Charles W. Henderson, Granville, O.
Wooster University Scientific Club,
*Mr. Frank H. McCombs, Wooster, O.
The Cuvier Press Club,
Mr. James W. Faulkner, Cincinnati, O.
Association of Ohio Teachers of Mathematics and Science,
*Professor S. E. Rasor, Columbus, O.
Ohio State University Scientific Association,
Professor Karl D. Swartzel, Columbus, O.
*Professor James R. Withrow, Columbus, O.
Oxford Science Club,
*Professor J. A. Culler, Oxford, O.
Otterbein Science Club,
*Mr. Richard M. Bradfield, Westerville, O.
Baldwin-Wallace Science Seminar,
*Professor E. L. Fullmer, Berea, O.

The following members of the old Tyndall Association, so potent in the scientific life of Columbus and Ohio in the seventies and eighties, were also present by special invitation:

Mr. H. N. P. Dole, Columbus, O.
Mr. Martin Hensel, Columbus, O.

Mr. Curtis C. Howard, Columbus, O.
Professor William R. Lazenby, Columbus, O.
Dr. C. L. Mees, Terre Haute, Ind.
Dr. T. C. Mendenhall, Ravenna, O.
Dr. Sidney A. Norton, Columbus, O.
Mr. D. E. Williams, Columbus, O.

In the business session the most notable action was the adoption of a constitutional amendment, suggested at the previous annual meeting, by which the date of the annual meeting is changed from Thanksgiving to March or April, the exact date to be fixed by the executive committee. By vote of the academy the next meeting will be held in the spring of 1916.

The trustees of the research fund announced a further gift by Mr. Emerson McMillin, of New York, of $250 for the encouragement of the research work of the academy.

As a result of the suggestions contained in the address by Dr. Mendenhall, on "The Relation of the Academy to the State and to the People of the State," a committee on legislation was appointed, consisting of Dr. T. C. Mendenhall, chairman, Professor F. C. Waite and Professor Herbert Osborn.

The previous affiliation of the academy with the *Ohio Journal of Science* was continued with minor modifications; but the incoming president was instructed to appoint a committee to confer with the committee on legislation and to "investigate carefully possible ways and means whereby the academy can successfully take over the *Ohio Journal of Science* and how soon this can be done, the committee to report back to the academy at its next annual meeting." President Hubbard appointed Professor J. Warren Smith, chairman, Professor Frank Carney, Professor F. C. Waite, Professor J. S. Hine and Professor C. G. Shatzer.

Forty-one new members were elected at the meeting.

The officers and standing committees for 1915–1916 will be as follows:

President—Professor G. D. Hubbard, Oberlin College.

Vice-president for Zoology—Professor F. L. Landacre, Ohio State University.

Vice-president for Botany—Professor M. E. Stickney, Denison University.

Vice-president for Geology—Professor T. M. Hills, Ohio State University.

Vice-president for Physics—Professor L. T. More, University of Cincinnati.

Secretary—Professor E. L. Rice, Ohio Wesleyan University.

Treasurer—Professor J. S. Hine, Ohio State University.

Executive Committee, together with the president, secretary and treasurer, members *ex-officio*—Professor L. B. Walton, Kenyon College, and Professor C. G. Shatzer, Wittenberg College.

Trustees of Research Fund—Professor W. R. Lazenby, Ohio State University; Professor M. M. Metcalf, Oberlin College; Professor N. M. Fenneman, University of Cincinnati.

Publication Committee—Professor J. H. Schaffner, Ohio State University; Professor C. H. Lake, Hamilton; Professor L. B. Walton, Kenyon College.

Library Committee—Professor W. C. Mills, Ohio State University; Professor F. O. Grover, Oberlin College; Professor J. A. Culler, Miami University.

Edward L. Rice,
Secretary

Delaware, Ohio

THE TENNESSEE ACADEMY OF SCIENCE

The sixth meeting (fourth annual meeting) of the Tennessee Academy of Science was held on November 26, 1915, at George Peabody College for Teachers, Nashville, Tenn. President W. E. Myer presided. The following papers were read and discussed:

"Why Potteries should be Established in West Tennessee," by Wilbur A. Nelson.

"Preservation of Our Forests," by R. S. Maddox.

"Cause of the Stylolitic Structure in the Tennessee Marble," by C. H. Gordon.

"Phosphate Rocks of Johnson County, Tenn.," by Olaf P. Jenkins.

"The Evolution of Mississippi River Craft as Influenced by Geographic Conditions," by Charles C. Colby.

"Recent Results in Mathematical Astronomy," by H. E. Buchanan.

"An Irrigation Slide for Prolonged Observation of Living Aquatics"; (*b*) "A Simple Device for Aerating Aquaria"; by Samuel M. Bain.

"Guessing as Influenced by Odd Numbers," by F. B. Dresslar.

"Nature and Origin of the Holston Marble Formation in East Tennessee," by C. H. Gordon.

"The Ordination of Sciences in Education," by R. I. Raymond.

Memorial Sketches of Deceased Members: (*a*) "Dr. William L. Dudley," by L. C. Glenn; (*b*)

"Dr. James A. Lyon," by J. I. D. Hinds; (c) "Mr. James H. Baird," by S. Cecil Ewing.

Annual address of the president: "The Probable Origin of the American Indian," by W. E. Myer.

The election of officers for the ensuing year resulted as follows:

President, Samuel M. Bain, University of Tennessee, Knoxville, Tenn.

Vice-president, Samuel M. Barton, University of the South, Sewanee, Tenn.

Secretary, Roscoe Nunn, U. S. Weather Bureau, 1235 Stahlman Building, Nashville, Tenn.

Treasurer, Archibald Belcher, Middle Tennessee State Normal School, Murfreesboro, Tenn.

Editor, A. H. Purdue, State Geological Survey, Nashville, Tenn.

The president appointed as members of the executive committee, J. I. D. Hinds, Castle Heights School, Lebanon, Tenn., and F. B. Dresslar, George Peabody College for Teachers, Nashville, Tenn.

ROSCOE NUNN,
Secretary

NASHVILLE, TENN.

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE one hundred and sixth regular meeting of the Botanical Society of Washington was held in the assembly hall of the Cosmos Club at 8 P.M., October 5, 1915. Thirty members and two guests were present. The following scientific program was given:

Some Recent Investigations in Sugar-beet Breeding (with lantern): MR. F. J. PRITCHARD.

The speaker presented a large number of tables and figures based upon ten years' experiments in sugar-beet breeding from which the following conclusions were drawn: Differences in the size, total sugar content and percentage of sugar of individual beet roots show no evidence of inheritance. There is no correlation between percentage or quantity of sugar of roots of ordinary sizes and their yield of seed, nor between their yield of seed and the average percentage of sugar in their progeny. Fluctuations in percentage and yield of sugar of beet families planted in progeny rows in alternation with check rows greatly exceed their real differences. The discontinuance of selection for one generation caused no deterioration, but some apparent gain in percentage of sugar. No improvement was obtained in yield or percentage of sugar from continuous selection. Both the good and the poor families transmitted average qualities. Fluctuations in percentage and yield of sugar are caused chiefly by irregularities of the soil. The nutritive conditions which favor the production of a large root cause a large tonnage of beets, but a low percentage of sugar. Even with a uniform stand certain rows and certain parts of the field produce a relatively small root and consequently a high percentage of sugar, while neighboring areas produce a large root and a low percentage of sugar. As the fluctuations in percentage and yield of sugar are large, they obscure real differences between varieties or families but real differences may be distinguished by planting each variety or family a large number of times.

Notes on Plant Parasitic Nematodes (with lantern): MR. L. P. BYARS.

After a few introductory remarks concerning the general characteristics of the three groups of nematodes—the free living, animal parasitic, and plant parasitic—the speaker indicated some of the more important anatomical and life-history features of species belonging to the last group. Emphasis was laid on the economic importance of and present distribution of *Tylenchus dipsaci,* the bulb and stem-infesting nematode; *Tylenchus tritici,* a nematode living in wheat kernels; *Aphelenchus armerodis,* the violet bud organism; and *Heterodera radicicola,* the gall-forming nematode, all of which are parasites introduced into this country. Illustrations and drawings were used to show the speaker's method of growing *Heterodera radicicola* in pure culture, and to indicate the effect of this parasite on its host.

The First Washington Botanical Society: MR. P. L. RICKER.

While collecting material for the bibliography and biography in the forthcoming Flora of Washington I first learned[1] of the existence of a Washington Botanical Society organized on March 13, 1817, with thirteen charter members, consisting of John Boyle, W. A. Bradley, Dr. John A. Brereton, Samuel Elliot, Jr., William Elliot, J. W. Hand, Dr. Henry Huntt, Maj. James Kearney, Rev. Dr. James Laurie, Dr. Alexander McWilliams, J. M. Moore, John Underwood and George Watterson. Subsequently six additional mem-

[1] Coville, Frederick V., "Early Botanical Activity in the District of Columbia." Records of the Columbia Historical Society, 5: 176–194. 1901.

bers were elected and three honorary members, consisting of Dr. Jacob Bigelow, Dr. William Darlington and Dr. William P. C. Barton. Meetings of the society were held until March 27, 1826, when the society adjourned sine die. It was ordered that the library of the society be deposited in the Washington Library. The herbarium was placed under the care of Dr. McWilliams, but its subsequent disposition has not been learned. The records of the society eventually found their way into a local second-hand book store and were presented to the late Dr. Lester F. Ward in 1883, remaining in his possession until his death, when his library was given to Brown University. After correspondence with the librarian of Brown University to learn if the records were there, formal request was made to the trustees of Brown University by the secretary of this society for the return of the records to Washington, which request was granted. The proceedings of the meetings for the first few years show considerable progress in the study of the local flora and offer much interesting historical data.

The fifteenth annual meeting of the Botanical Society of Washington was held in Room 33, West Wing, New Department of Agriculture Building at 1:30 P.M., October 19, 1915, with twenty-four members present. The report of the executive committee showed the following facts concerning the activities of the society for the preceding year: Average attendance of seventy-three members and guests. Seven members were lost during the year, one by resignation and six by change of residence. Eighteen new members were elected, making a total net membership of one hundred and forty-three. One joint meeting was held with the Washington Academy of Sciences. Twenty-one formal scientific papers were presented and the following visiting botanists were entertained: Professor J. C. Bose, Drs. Camillo Schneider, F. Kolpin Ravn, Otto Appel and Gentaro Yamada.

The customary reports were presented and approved and the following officers elected for the ensuing year: *President,* Professor A. S. Hitchcock; *Vice-president,* Dr. J. W. T. Duvel; *Recording Secretary,* Chas. E. Chambliss; *Corresponding Secretary,* W. E. Safford; *Treasurer,* Dr. C. E. Leighty; *Vice-president in Washington Academy of Sciences,* Dr. R. H. True.

Perley Spaulding,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 490th meeting of the society, held November 2, 1915, Dr. Walter Hough spoke on "Progress in Anthropology in California." He showed how means of transportation and food and water supplies influenced the direction of migrations in California. The entire Pacific coast was described as a swarming place of tribes offering perplexing problems to the ethnologist. Among others, Bancroft, Lummis and Cowan, have made contributions in this field. The great museum collections in San Francisco and Los Angeles were described and the important researches of Kroeber and others at the University of California; also a study of the 400 shell mounds of San Francisco bay made by Gifford, Nelson and Waterman. The exhibits at the expositions have been previously described before the society.

At the 491st meeting of the society, held December 7, 1915, Mr. Francis LaFlesche read a paper on the "Right and Left in Osage Rites." The Osage, in the early days of their tribal organization, believed that all life proceeded from the fructifying union of the sky and the earth and founded their gentile organization upon this concept. They divided the people into two parts, the "Tsi-zhu" (household), representing the sky, and the "Ho^n-ga" (sacred), representing the earth. They likened the tribe to a living man facing the east, the Tsi-zhu division being on the north, the Ho^n-ga on the south. When organizing a war party, however, the position of the village was changed so that the symbolic man faced to the west. All ceremonial movements were made with reference to the right and left sides. The same idea determined the placing of symbolic articles used in the ceremony and appeared in the daily customs of the people.

In discussing the paper, Miss Alice C. Fletcher and Messrs. Hodge, Swanton, Fewkes, Mooney and Michelson referred to similar concepts and organizations in other tribes, as among the Hopi of the south and the Piegan of the north. Several thought that the origin of 6 as a ceremonial and sacred number had reference to the six "cardinal points," north, south, east, west, up, and down. Explanations were also suggested for the preference given the left hand in these ceremonies. The sky concept possibly had a religious significance.

Daniel Folkmar,
Secretary

SCIENCE

FRIDAY, FEBRUARY 18, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

UPBUILDING NATIONAL VITALITY—THE NEED FOR A SCIENTIFIC INVESTIGATION[1]

IF American democracy is to survive, it must be made more efficient—socially, industrially, politically. If Americans are to work out their national destiny unvexed and unhampered by foreign interference or domination, they must no longer endure the hazard of unguarded peace.

These conclusions—right or wrong—have been firmly fixed in the minds and hearts of a vast number of Americans.

For many months they have observed the great Christian nations of Europe rending one another with the ferocity of wild beasts—a savage, brutalizing struggle to destroy life and property, to increase human pain and suffering. The awful horror of it, the appalling cost of it in men, money and misery has passed beyond the grasp of the imagination.

Civilization's guarantees against such a man-made calamity have been dishonored, treaties torn up, the laws of common humanity and of God designedly outraged, and the rule of the sword substituted.

On one flank America has this extraordinary recrudescence of the spirit of national outlawry and conquest. On the other it has a rapidly advancing military power supported by an aggressive, warlike people with colonizing policies.

The possibility that American democracy may eventually be squeezed or crushed between these two great forces of militarism can no longer be ignored.

[1] Address of the chairman and retiring vice-president of Section I, the American Association for the Advancement of Science, Columbus, December 29, 1915.

Adequate national defense is the only answer to this extraordinary situation, and it must continue until the spirit of militarism and conquest is subdued in other powerful nations.

There are good-intentioned people who oppose this policy of national preparedness against war. For protection against a foreign foe they stand upon the theory:

In weakness there is strength.

They also tell us that our duty to the great brotherhood of man is higher than our duty to our country.

If we are worthy of belonging to the human species we must know that our first duty is to our own—to faithfully guard the lives and the happiness of that portion of the human family given into our care, and to religiously discharge our responsibilities as trustees for our own posterity.

However we may abhor war, it is a self-evident truth that to-day a nation without the will or the capacity to fight for its own peace, honor or national entity commands little respect at home or abroad. It has neither influence nor place in the councils of the world.

Our primary obligations to humanity and to posterity are to guard our national birthright now, and to hand down a race that will have, not only the will, but the physical power and endurance to defend and maintain our ideals, and our institutions in their full integrity.

TAKING STOCK OF NATIONAL VITALITY

Upon the health and strength of the people depend the safety of the state and the continued advance of our civilization.

With this important truth in mind, and also the constantly increasing demand for physical fitness of the individual in our industries as well as in war, let us consider some of the evidences of declining power of our people to endure the physical stress and strain of modern life.

We will then be able to appreciate the need of a national vitality commission to study and report upon the present physical status and trend of our people. Such a commission should be authorized by congress and appointed by the President and consist of, say, fifteen members selected from a list of our most eminent authorities in this field of science.

An official body of this character would command attention and confidence. It would not only enlighten the public, but it would stimulate to action our school and health officials, and the appropriating authorities back of them, in spreading knowledge of individual hygiene and healthful living generally. This would help to check both communicable and degenerative affections which are causing such an excessive drain upon national vitality.

If the state can teach us how to combat germ diseases (which it is doing), why not organic diseases, which are virtually all preventable or deferable?

THE DECLINING DEATH RATE

Modern progress has freed us from many mental and physical burdens. It has given us wealth, comforts, luxuries, pleasures and opportunities for gaining knowledge far beyond the dreams of our forefathers. It has removed many dangers from our paths and lengthened the average years of life, all of which we gladly acknowledge.

But we must also recognize that while American life strain has decreased in some respects it has increased in others. We must admit that our civilization, in addition to its blessings, has brought us habits and hazards of life and degenerative influences which promote physical deterioration.

Many people who give little thought to

this subject insist that there is but one side to the shield. They see only where American life strain has been reduced and resent as a species of treason any reference to adverse tendencies. Naturally, this results in misunderstandings and misinterpretations of simple facts.

For instance, the average person interprets the declining general death rate and the increase in the average years of life as a sign that the race is growing stronger, that its capacity to stand the stress of modern life is increasing. The fact is overlooked that the decline in the death rate in recent years is almost wholly due to the saving of lives in infancy, childhood and early adult life from the germ diseases. These diseases are really accidents. They are not the result of the wear and tear of life. The declining death rate means, then, not that we have grown physically stronger, but that we have learned to step around certain dangers.

The advance in medical science and in general intelligence is saving lives in all age periods. But this does not indicate any gain in our vital strength. In fact, the death rate in middle life and old age from the degenerative diseases has increased steadily for years.

Another factor that is often misunderstood is the effect of the survival of the weak. Formerly only the strong survived infancy. In the past thirty-five years many lives weakened by germ diseases have been saved, and when they have had time to reach age forty and beyond they will undoubtedly affect the death rate in that period. The increase which has already occurred in the mortality rate in that period must be charged to other causes.

This low-powered group will need careful health guidance to reach middle life and is obviously an element of weakness in the upbuilding of national vitality.

THE LOW-POWERED GROUP

We rejoice over our marvelous increase in wealth and in the wonderful development of time-saving and labor-saving devices, and we would not go back to the old living conditions if we could.

We must recognize, however, that these extraordinary changes in our methods of living during the past two generations have operated greatly to disturb our race stability.

Extravagance, luxury, nervous stress and an extraordinary increase in sedentary occupations have resulted, and caused a marked increase in American life strain. In our efforts to crowd a lifetime of work and pleasures into a few years we have developed in a large number of people the intense life with its excessive indulgence, its intemperate eating, drinking, playing and living generally.

The peril of our nation in this trend is obvious to every reader of history.

In the natural order of things, there are many millions of physically substandard people in our vast population. These extraordinary changes in living conditions have apparently caused an abnormal increase in this great group of low-powered Americans.

But whether or not this impaired element is increasing, there is no questioning the assertion that this drain on the vitality of the nation, now going on from preventable cause, is excessive and should and can be checked.

INFLUENCE OF EXCESSIVE INDIVIDUALISM

In the ultra-individualist we find selfishness in the most dangerous form. He views all things from the angle of his own comfort and pleasure. He has an overpowering sense of personal independence. He flouts things sacred and semi-sacred that tend to curb it. He freely defies the laws

of health. He resents restraint in any form. A self-worshiper, neither the *good* of the majority nor the *will* of the majority claims his allegiance. He is apt to fail his country in both peace and war. He has lost the "herd spirit." His patriotism has withered and vanished under the blighting influence of love of self and of personal ease. To what extent would those afflicted with all, or a part, of the weaknesses of this product of our civilization contribute to national defense and to upbuilding the moral, the civic or the physical fitness of the race?

To this selfish, lawless spirit of the ultra-individualist which in whole or in part prevails among so many of our people, we may reasonably charge our excessive murder and suicide rate, and our indifference to the increasing waste of life from preventable accidents and disease.

It is possible that the report of the broad investigation proposed would induce the American people to place a higher value on human life.

TIME-SAVING MANIA

As a contributing cause to nerve strain and physical deterioration, our time-saving mania must not be overlooked. Those afflicted with this modern malady avoid walking and every physical movement that is not strictly necessary. The hurry habit is so firmly fastened upon us that it has changed the poise and even the manners of a vast number of people.

Thus the habit has grown upon us to express ourselves in brief, incisive terms. Abruptness enters into our personal intercourse with relatives and friends. Old-time politeness and kindly consideration for the dignity and sensibilities of others in our public and business contact is sadly lacking in many of us. The traits of calmness and deliberation seem to be deserting us and in their place we have the imperative demand for hurried councils and quick judgments.

Our every need, our every sense must be served quickly or impatience and often rudeness follows. Much irritableness and bad temper are the natural consequences of such a life.

These and other habits of self-indulgence are affecting the mental poise and stability of the "strenuous" class, and largely account for the so-called "high nervous tension" under which they live. This is a serious form of life strain, and it is by no means confined to the business or well-to-do class.

This strain is bound to react sooner or later on the heart, arteries and kidneys, and especially upon the nervous system, adding to our already large family of neurasthenics. To what extent can we depend upon this particular element of our substandard citizens for the defense of the nation and the upbuilding of the race?

DISUSE OF LIMBS AND MUSCLES

The decline in physical activity has had an important bearing upon national vitality. We have millions of people, mostly bred from generations of outdoor or muscularly active ancestors, who are now working in offices, stores and the industries where little or no physical exertion or even concentration of mind is required.

It is no longer the rich who ride in "shayses." The wage-earner is whisked to and from work by electricity or gasoline. Instead of fabricating his output by physical toil, he fashions it by the simple process of feeding, watching, or adjusting a machine. A vast number of people in the rural sections, as well as in our cities, are earning their living with little or no muscular effort. This is a glorious advance over old methods, but there is the penalty. This change produces a constantly increas-

ing line of recruits for the low-powered or substandard group. Their limbs, joints and muscles were made to use. These naturally become soft and weak from disuse. To run three blocks would doubtless give the entire nation the "charley horse."

As time rolls on, the seriousness of this problem will increase, for the decline in our physical activity is bound to continue. Edison tells us invention, especially in electricity, is still in its infancy in developing time- and labor-saving methods.

OUR INDUSTRIAL ARMY

When men are wanted to fight for their country, the first consideration is health and strength of body. The initial requirement is to undergo a physical examination to determine their fitness for service. The weak are separated from the strong. The physically fit must do the fighting for the physically impaired.

And what of our great industrial army which makes the fighting army possible?

We not only have the communicable and occupational diseases and hazard of accident to combat in this group, but a marked increase in mortality from diseases of the heart and other important organs that bear the heaviest burden of life strain.

Based upon the experience of the Life Extension Institute, it is estimated that of the twenty-eight million men, age eighteen to sixty, in the United States, eight million five hundred thousand show evidences of approaching organic disease, or already have it in one or more forms.

This can only be checked and the average vitality of this group built up by teaching these people, and inducing them to observe, the laws of individual and household hygiene as applied to modern conditions. Is it not worth while?

If it is so important that our fighting men should be in good physical condition, is it not important that the great army of workers upon whose physical fitness, skill and loyalty the fighting army must depend for existence should also be considered in our plans for national defense?

Are we to depend upon weaklings and invalids alone to feed, clothe and equip the army in the field, and to provide it with ammunition and arms?

Governmental sick insurance for workers appears to be near at hand. Sick insurance is a great need, but this is not prevention. It is relief after the damage is done. Why wait until the victim is stricken with disease before teaching him how to avoid it?

It is to reduce this vast body of substandard Americans, who are physically unable to do their full share either in the defense or the progress of the nation, that a scientific inquiry under governmental control is urged. Surely the wisdom of such an inquiry should appeal to life insurance companies and industrial employers, as well as to our military authorities.

PHYSICAL DEVELOPMENT

It is gratifying to know that interest in athletics and outdoor life has increased in recent years. But, unfortunately, the active recruits to this class have apparently not increased in proportion to the gain in population.

The growing tendency toward habits of physical ease is a dangerous factor in our civilization. Even in our schools and colleges athletics are confined chiefly to a few enthusiastic well-trained individuals. The great majority of students do not take an active part even in mild physical exercises. Their interest is often keen, but their athletics as a rule are confined to clapping their hands and exercising their vocal cords at contests where the few entertain the many. Even where the best of instructors

and equipment are provided, there are large numbers who avoid gymnasium and outdoor work and stick to the lazy line of least exertion.

We do not want and could not have a nation of highly trained athletes. What we want is a race of people who stand erect, who have good, average physiques and sound organs. A national vitality commission could study and recommend the best means of teaching our people and of stimulating them to action in this vitally important matter of exercises, and especially of natural outdoor exercise.

HIGH-POWERED SOLDIERS

Modern methods of war call for the very highest state of physical efficiency on the part of the soldier. The strain upon the physique and the nervous system is excessive.

How would our sedentary group stand it? They would doubtless do their part well, if the enemy were sufficiently obliging to allow them time to drill and harden and restore their limbs and muscles to normal condition. As to their fitness, untrained, listen to a civilian member of the Plattsburg experiment of last summer, Mr. Ralph W. Page:

THE RAW RECRUIT

. . . We advanced at top speed for miles; we crawled over ten thousand acres, and we charged until dizzy all over the country. This, my friend, is no easy task. It gives you an abnormal aspect of the real fighting man. To advance a mile on your belly or by rushes carrying thirty-eight pounds besides shooting an eight pound rifle the whole way, after a long march, even when no burst of shrapnel enhances the entertainment, is very strenuous business. . . .

Now the very essence of this [military service] is physical condition. That as a nation we are not in such condition was very strikingly shown at the maneuvers. This Plattsburg regiment was recruited largely from athletes, polo and football players, militiamen, big game hunters, and such people probably far above the average of our citizens. They had a month's very vigorous training. And yet ten miles was the utmost limit they could cover as a body in march in one day. Yet the 30th United States Infantry two days before the amateur war began arrived at camp about 4:30 in the afternoon, the band playing "What the hell do we care," having covered thirty-two miles to a man since reveille.

If this is the experience of self-selected soldiers who undertook the work because they knew of their own trained physical condition, how long would it take to "rebuild" a regiment of men from our large body of untrained citizens composed partly of men from the great physically low-powered group?

ORGANIC DETERIORATION

Apparently the most significant result of the various changes in our living habits is found in our declining power to resist the strain of life on the heart, arteries, kidneys and the nervous and digestive systems.

Compared with past decades, the increase in mortality from the early breaking down of these organs is very marked. The records of the last census show that the increase continues in the younger as well as the older age groups. This points to the shortening of the valuable productive period of life. These indications are well attested. They can not be disposed of by the easy process of denying the statistics without investigation. Nor can the extraordinary increase in cancer be explained in this convenient way.

The early breaking down of these important organs points to a decline in the vitality of our people in the mature and most useful period of their lives, and presents a phase of the problem meriting the most careful study and consideration.

THE DECLINING BIRTH RATE

That our birth rate is declining is freely conceded. The ratio of decrease we do not

know, as we have not yet reached that stage of intelligence which grasps the importance of keeping a record of the births and deaths in all sections of our country.

We know that we have made a great advance in conserving infant lives. Therefore, it may be said that if our rapidly developing civilization has operated to reduce the birth rate, it has also provided us with life-saving methods to offset the loss. But the indications are that this gain in this baby-saving is not sufficient to offset the decline in the birth rate.

The vital importance of the birth trend as a national problem is emphasized by the growing practise of birth control by parents, and by the indifference of so many of our young people to marriage. What we need is not necessarily larger families, *but more* families. The proportion of married people should have greatly increased under our new civilization. A large proportion of our 17,000,000 unmated men and women should be married. The divorce habit should have declined, but it has grown to astonishing proportions. These are all recognized facts and have a very direct bearing upon the problem of race survival, both as to quality and quantity.

Eugenics—the improvement of the breed—and the general question of race protection should receive national recognition and a sincere effort should be made to impress the public with their true purpose and importance.

WHY A NATIONAL VITALITY COMMISSION IS NEEDED

To summarize:

National liberty rests upon national vitality. The health and strength of the people are therefore fundamental factors in national defense.

Neither our freedom nor our race can be protected and developed by weak-limbed, soft-muscled, low-powered men.

Notwithstanding our progress in prevention, the physically substandard and low-powered group, which numbers millions, is apparently increasing abnormally.

The decline in the general death rate and the increase in the average length of life is due, not to an increase in the vital strength of the people, but to the fact that we are learning how to step around certain dangers—the germ diseases. The death rate from the wearing out of the organs is steadily increasing.

Some of the conditions and reasons justifying the appointment of a scientific commission to investigate and report on the trend of national vitality may be found in the following

BILL OF PARTICULARS

1. Our unprecedented prosperity and invention of labor- and time-saving devices have developed habits of extravagance, luxury, over-indulgence in both work and physical ease, which have disturbed our race stability.

2. The high-tension element is obviously increasing. Nervous strain and mental stress are constantly adding to low-powered group.

3. An extraordinary increase in sedentary life has occurred.

4. The overfed and under-exercised groups are increasing. Result: obesity and weak limbs, soft muscles—due to disuse. Easy and early victims of organic disease.

5. Prevalence of defective teeth, diseased gums (largely due to non-use of teeth), impaired vision, baldness, bad posture, flat-foot, constipation, increased by sedentary occupations.

6. A marked increase has occurred in the death rate from diseases of the nervous and digestive systems, heart and arterial system, kidneys and urinary system—19 per cent. in ten years.

7. At least 8,500,000 men (of total 28 million) age eighteen to sixty have evidences of approaching organic disease or already have it in one or more forms.

8. Health and life waste from tuberculosis, typhoid fever and other germ diseases is still excessive; about 350,000 deaths annually.

9. The mortality from cancer is rapidly increasing. Annual deaths about 75,000.

10. Accidental deaths have steadily increased and now number nearly 90,000 annually.

11. Four out of every ten deaths (all causes) are preventable.

12. Two billion dollars is the estimated annual economic waste due to preventable sickness and preventable deaths in the United States.

13. The birth rate is steadily declining—especially among the well-to-do classes—and at least 200,000 babies die every year from preventable disease.

14. There are 9,000,000 unmarried women and 8,000,000 unmarried men in the United States.

15. The divorce rate is increasing. In Chicago one suit is filed for every six marriage licenses issued.

16. Not less than 75 per cent. of school children need attention for physical defects or impairments prejudicial to health.

17. The large number of mental defectives and backward children in our schools presents a serious educational problem.

18. Idiocy and insanity are apparently increasing.

19. An enormous number of people are suffering from drug habits and alcoholism. The use of cigarettes has doubled within the past five years.

20. Medical men claim that victims of venereal disease are rapidly increasing.

21. Suicides continue to increase and have now reached the enormous total of over 15,000 annually. In ten years, 42,000 people have taken their lives in 100 cities.

22. America's murder rate is extraordinary. About 80 per million as against 7 to 20 for other nations. But a small number are punished for their crimes.

The adverse influence of this great body of physical and mental defectives upon the material, intellectual and moral advance of the nation, and upon the quality of present and future citizenship is self-evident.

We have made wonderful progress in fighting germ diseases, but no war is waged against organic diseases.

If the government may teach people sanitation—public hygiene—why not individual hygiene—the care of the body and its organs?

If it is a good thing to teach children to avoid illiteracy, why not how to avoid ill health?

If it pays to medically examine our soldiers periodically, why not teach the people to adopt the same health- and life-saving practise?

If we can afford to investigate the condition of swine and cattle, and of rivers and harbors for purposes of improvement, surely congress can afford to provide this National Vitality Commission to improve human efficiency and to save human life.

The primary duty of organized society is to guard the health and lives of those who compose it.

E. E. Rittenhouse
Life Extension Institute

THE REVISION OF EOANTHROPUS DAWSONI

The prehistoric archeologist sometimes uncovers strange bedfellows; no other discovery is quite so remarkable in this respect as the assemblage from the now famous gravel pit at Piltdown Common, Sussex, England. Nature has set many a trap for the scientist; but here at Piltdown she outdid herself in the concatenation of pitfalls left behind. Parts of a human skull, half of an ape-like lower jaw, a canine tooth also ape-like, flints of a pre-Chellean type, fossil animal remains, some referable to the Pliocene, others evidently Pleistocene; all at least as old as the gravel bed, some of the elements apparently derived from a still older deposit.

Has not this dazzling combination blinded the discoverers and indirectly some of their colleagues even at a distance, because of the high pitch of expectancy to which recent discoveries in the prehistoric field have, not without reason, contributed? Under the circumstances, such blindness if only temporary would be pardonable and comparatively harmless; but serious danger lurks in the possibility of its persisting long enough to become an obsession and a hindrance to future progress in this particular field.

All the cranial fragments, including the nasal bones, are human and belong evidently to the same individual. They were however so incomplete as to leave room for a difference

of opinion especially in regard to the capacity of the brain-case. Authorities are quite generally agreed that the cranium as well as the brain embodied certain primitive characters, even though the brow-ridges were smaller and the forehead less retreating than in Mousterian man (*Homo neandertalensis*).

When it came to fitting the fragmentary lower jaw to the cranium, difficulties multiplied; it was the right half of the mandible, and the articular condyle was missing. Even had it been present, there was no right glenoid fossa to receive it. However a part of the left temporal bone, including its glenoid fossa, had been preserved, but it was typically human. The lack of the parts necessary to bring the mandible and cranial base into actual contact served to cloak the lack of harmony existing between the two. This lack of harmony was likewise further obscured by the incompleteness of the symphyseal region.

The proximity of the brain-case and lower jaw in the gravel bed, their apparent agreement in size and the non-duplication of parts present; the fact that they bore the same marks of fossilization, showing "no more wear and tear than they might have received *in situ*"; the failure of previous discoveries to confirm the presence of higher apes among European Pleistocene faunas; and perhaps above all the belief that a "generalized type" had been found led inevitably to the association of cranium and mandible as parts of one individual or species. Was such a conclusion the only logical one; was it even scientifically justifiable?

In dealing with the contents of a gravel bed, it is easy to overestimate the importance of proximity. Had Piltdown been a cave deposit or a camp site, the case for proximity might have been somewhat stronger; even in these there is abundant opportunity for chance association. In any event association can never be made to take the place of articulation; and so far as Piltdown is concerned, nothing short of the actual articulation of the mandible with the skull should have sufficed to outweigh the lack of harmony existing between these parts.

The only course to pursue then is to study the parts separately, classifying each on its own merits just as if the mandible had been found at Piltdown and the brain-case in a similar deposit somewhere else in Sussex. When this is done, the problem is at once clarified and there appears a solid foundation on which to build. Viewed in this light, the lower jaw is not only no longer human, it does not belong even to a generalized type. In justice to Dr. A. Smith Woodward and his highly meritorious researches, it should be acknowledged before proceeding further that no one has given a more exact description of the Piltdown mandible than he; for he was the first to point out its resemblance to that of a chimpanzee and added: "It seems reasonable to restore the fossil on this model." Thus far he was on safe ground; but instead of stopping there, he completed the sentence with: "and make the slope of the bony chin intermediate between that of the adult ape and that of *Homo heidelbergensis*." This proved to be the parting of the ways; for after a further description of both cranium and mandible, we find the following:

> The specimen therefore represents an annectant type, and the question arises as to whether it shall be referred to a new species of *Homo* itself, or whether it shall be considered as indicating a hitherto unknown genus. The brain-case alone, though specifically distinguished from all known human crania of equally low brain-capacity, by the characters of its supraorbital border, and the upward extension of its temporal muscles, could scarcely be removed from the genus *Homo;* the bone of the mandible so far as preserved, however, is so completely distinct from that of *Homo* in the shape of the symphysis and the parallelism of the molar-premolar series on the two sides, that the facial parts of the skull almost certainly differed in fundamental characters from those of any typically human skull. I therefore propose that the Piltdown specimen be regarded as the type of a new genus of the family Hominidæ, to be named *Eoanthropus* and defined by its ape-like mandibular symphysis, parallel molar-premolar series, and narrow lower molars which do not decrease in size backwards; to which diagnostic characters may probably be added the steep frontal eminence and slight development of brow-ridges.

The species of which the skull and mandible have now been described in detail may be named *Eoanthropus dawsoni*, in honor of its discoverer.

From the start there were not lacking those who hesitated to accept the cranium and mandible as belonging to the same individual. This was the stand taken by Sir Ray Lankester on the occasion of the first report of the discovery before the Geological Society of London in December, 1912. On the same occasion Professor Waterston was even more emphatic, saying it was very difficult to believe that the two specimens could have come from the same individual, since the mandible resembled that of a chimpanzee, while the skull was human in all its characters. In a later paper on the Piltdown mandible,[1] he concludes that referring the mandible and cranium to the same individual would be equivalent to articulating a chimpanzee foot with the bones of a human thigh and leg.

Objections soon came also from France and Italy. Basing his opinion on the cranial characters, Dr. R. Anthony[2] thought the specific name should have been *Homo dawsoni* instead of *Eoanthropus dawsoni*. About the same time a similar conclusion was reached by Dr. V. Giuffrida-Ruggeri. To Professor Marcellin Boule,[3] the Piltdown mandible is exactly like that of a chimpanzee; so that if this mandible had been found alone in the gravels of Piltdown associated with remains of Pliocene animals, it would certainly have been called *Troglodytes dawsoni*. Without rejecting Smith Woodward's interpretation, which Boule considers to be within the realm of the possible, even of the probable, it would nevertheless seem to him prudent to leave the matter still open. He objects to the choice of the name *Eoanthropus*, and finally in his judgment Woodward's restoration does not ring true (*elle sonne faux*).

It was this false note that impressed me most of all on seeing the restoration for the first time. The inherent difficulty in making Dr. Woodward's restoration ring true rests on the attempt to adjust parts that were never intended for each other. This would seem to have been demonstrated to an absolute certainty by Dr. Gerrit S. Miller[4] of the United States National Museum. He has compared the cast of the Piltdown mandible with casts of chimpanzee mandibles mutilated in the same manner, and finds not only similarity, but absolute identity. During the month of December, 1915, the writer was in Washington and examined the material on which Miller bases his conclusions, conclusions from which it would seem impossible for any one to escape, who approaches the question with an open mind. In an article on "Recent Progress in Vertebrate Paleontology," which appeared in Science[5] after the present article was begun, one of the joint authors, Dr. W. D. Matthew, says that Dr. Miller's "argument is convincing and irrefutable." The ape-like canine tooth found at Piltdown by Father Teilhard and referred by Woodward to the right side of the lower jaw, is considered to be the left upper canine by Miller, who thus agrees with the views previously expressed by Mr. A. E. Anderson and Dr. W. K. Gregory.

Regarding the Piltdown specimens then, we have at last reached a position that is tenable. The cranium is human as was recognized by all from the beginning. On the other hand, the mandible and the canine tooth are those of a fossil chimpanzee. This means that in place of *Eoanthropus dawsoni* we have two individuals belonging to different genera, namely: (1) *Homo dawsoni*, and (2) *Troglodytes dawsoni* as suggested by Boule, or *Pan vetus*, sp. nov., if we adopt Miller's nomenclature.

Such a revision does not by any means minimize the importance of the Piltdown discovery. On the other hand it contributes to our knowledge of the fossil fauna of the period in question by the addition of the chimpanzee to the list. As for the Man of Piltdown, he still exists and is quite as ancient as he was before the revision, which is saying a good deal; even if he is robbed of a muzzle that ill became him.

[1] *Nature*, November 13, 1913.
[2] *Rev. anthropologique*, September, 1913.
[3] *L'anthropologie*, Jan.–Avril, 1915.
[4] "The Jaw of the Piltdown Man," Smithsonian Misc. Colls., Vol. 65, No. 12, November, 1915.
[5] January 21, 1916, p. 107.

The only thing missing is *Eoanthropus*, and since he was never there anyway, the loss is small; besides, we can well afford to continue our search and live in the hope that he may be caught next time. Meanwhile the restorations by Woodward, McGregor and others may still serve a more or less useful purpose as substistutes for *Eoanthropus* until he shall have been found.

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PROVISION FOR THE STUDY OF MONKEYS AND APES

BIOLOGISTS are generally agreed that the study of the primates, and especially of the monkeys and anthropoid apes, is of extreme importance. It is evident that this work, nevertheless, has been neglected. We have but fragmentary and unsatisfactory knowledge of the structure and development (gross anatomy, histology, embryology) of most of the primates; we know less, definitely, concerning their physiological processes, diseases and pathological anatomy; still less, of the phenomena of heredity and of their life history; and next to nothing, with certainty, concerning their instincts, habits, other individual modes of behavior, mental life, and social relations.

The reasons for this ignorance where knowledge might reasonably be expected are not difficult to discover. Most investigators are either impelled or compelled by circumstances to work on easily available and readily manageable organisms. Many of the primates fail to meet these requirements, for they are relatively difficult and expensive to obtain by importation or breeding, and to keep in normal condition. It is clear from an examination of the literature on these organisms and a survey of the present biological situation that the neglect by scientists of systematic study of all of the primates excepting man is due, not to lack of appreciation of their scientific value, but instead, to technical difficulties and the costliness of research.

For hundreds of years men have been interested in the various types of lower primates and have more or less casually and incidentally studied aspects of their lives. But thus far there has been no definite plan or program for the systematic and continuous study of these animals. In view of the obvious and urgent need of such a program for research which is admittedly of practical as well as theoretical importance I venture to present to my scientific colleagues the following briefly sketched plan.

There should be provided in a suitable locality a station or research institute which should offer adequate facilities (1) for the maintenance of various types of primates in normal and healthy condition; (2) for the successful breeding and rearing of the animals to many generations; (3) for systematic and continuous observation under reasonably natural conditions; (4) for experimental investigations from every significant biological point of view; (5) for profitable cooperation with existing biological institutes or departments of research throughout this country and the world.

The institute should be located in a region whose climate is in high degree favorable to the life of a variety of lower primates and to man. It is eminently desirable to avoid, in the interests of scientific achievement, an enervating tropical climate and unnecessary isolation from civilization and from centers of scientific activity. Since it is probably impossible to find a location which would be ideal for both subjects and observers, it will doubtless prove necessary to sacrifice in a measure the interests of each. During the past three or four years, I have accumulated information bearing on the several problems involved in the locating of an anthropoid station and have had opportunity to prospect for such an institute in widely separated regions. Chief among the regions considered are Borneo, Hawaii, southern California, Florida, the Panama Canal Zone, Jamaica and the Canary Islands. Of all of these, southern California seems at present most promising, and although it is not perfectly certain that any or all of the anthropoid apes can be successfully bred there (various other primates

can be kept and bred successfully), it seems eminently desirable to test the matter thoroughly before locating an institute in any less accessible or climatically less favorable part of the world.

Given adequate provision in the shape of a scientific establishment for the study of the primates in their relations to man, the following program might be carried out: (1) systematic and continuous studies of important forms of behavior, of mind, and of social relations; (2) similar studies of physiological activities, normal and pathological, with adequate provision for medical research; (3) studies of heredity (genetics), life history, embryology; (4) research in comparative anatomy, including gross anatomy, histology, neurology and pathology.

Each of these several kinds of research should be in progress almost continuously that no materials or opportunities be needlessly wasted. It would be necessary to provide, first of all, for those functional studies which demand healthy and normally active organisms whose life history is known intimately and completely. Simultaneously with observations on behavior, instinct and social relations, and often upon the same individuals, genetic experiments could be conducted. After the usefulness of an animal in these psychological, behavioristic, or genetic lines of inquiry had been exhausted, it might be made to render still further service to science in various medical, physiological or pathological inquiries. And finally, the same individual might ultimately be used for various forms of anatomical research. Thus the usefulness of a lemur, a monkey or an ape, as research material, might be maintained at a high level throughout and even beyond the period of its life history, that is, for several years.

The necessity of some such economical use of primate materials as has been suggested is due, clearly enough, to the high cost of breeding and maintaining the animals. It would be inexcusably wasteful to maintain a primate or anthropoid station for psychological observations alone, or indeed for any other narrowly limited biological research.

The establishment under consideration should be permanent, since for many kinds of investigation it would be necessary that the life history of individuals be intimately known for many generations. With the lower primates, a generation might be obtained in two to five years; with the higher, not more frequently than ten to fifteen years. It is therefore probable that the value of the work done in such an institute would continue to increase for many years and would not reach its maximum short of fifty or even one hundred years. Ultimately, the interests of the institute might come to include other organisms in addition to the primates, and thus in the end, the most varied sorts of biological information might be brought to bear, from the broadly comparative point of view, upon the problems of human life. This would mean a gradual transformation of what was originally founded as a station for the special study of the primates into an inclusively psycho-biological institute.

Adequate provision in a research institute for the study of the various types of primates would demand a staff of several highly trained and experienced biologists. The following organization is suggested as desirable, although, as indicated below, not necessarily essential in the beginning: (1) an expert especially interested in the problems of behavior, psychology and sociology, with keen appreciation of practical as well as of theoretical problems; (2) an assistant trained especially in comparative physiology; (3) an expert in genetics and experimental zoology; (4) an assistant with training and interests in comparative anatomy, histology and embryology; (5) an expert in experimental medicine, who could conduct and direct studies of the diseases of man as well as of the lower primates and of measures for their control; (6) an assistant trained especially in pathology and neurology.

To this scientific staff of six highly trained individuals there should be added a business manager, a clerical force of three individuals, a skilled mechanician, a carpenter, and at least four laborers.

The annual expenditures of an institute with such a working staff would, in Southern Cali-

fornia, approximate fifty thousand dollars. It would therefore be necessary that it have an endowment of approximately one million dollars.

In the absence of this foundation, it would of course be possible to make a reasonably satisfactory beginning on the work which has been outlined in the following less expensive manner. A working plant might be established, on ground rented or purchased at a low figure, for about ten thousand dollars; the salary of a director, his assistant, a clerical helper, and combined mechanic and laborer might be estimated at the same figure; the cost of animals and of maintenance of the plant would approximate five thousand dollars. Thus, we should obtain as an estimate of the expenditures for the first year twenty-five thousand dollars. Without expansion, the work might be conducted during the second year for fifteen thousand dollars, and subsequently it might be curtailed or expanded, resources permitting, according as results achieved and in prospect justified.

An institute established on such a modest basis as this still might render largely important scientific service through its own research and through organized cooperation with other existing research establishments. Thus, for example, supposing that behavioristic, psychological, sociological and genetic inquiries were conducted in the institute itself, animals might be supplied on a mutually satisfactory basis to institutes for experimental medicine, for physiological research, and for anatomical studies. Under such conditions, it is conceivable that extremely economical and good use might be made of all the available primate materials. But it is not improbable that even cooperative research would prove on the whole more profitable, except possibly in the case of morphological work, if investigators could conduct their studies in the institute itself rather than in distant laboratories. In any event, the idea of cooperation should be prominent in connection with the organization of a research station for the study of the primates. For thus, evidently, scientific achievement in connection with these important types of animal might be vastly increased over what would be possible in a single relatively small institution with a limited and necessarily specialized staff of workers.

Finally, I wish to emphasize the important relations of the plan which I have outlined to strictly human interests and problems. It is eminently desirable that all studies of infra-human organisms, and especially those of the primates which are most similar, structurally and functionally, to man, should be made to contribute to the solution of our own intensely practical, medical, social and psychological problems. During our own generation, it has been amply demonstrated that knowledge based upon observation of other organisms may be of extreme value to man, and there is every reason to suppose that the solution of many of the most interesting and pressing problems of experimental medicine, of human genetics, physiology, psychology, sociology and economics may be solved, at least in large measure, most directly and economically through the use of the monkeys and anthropoid apes.

Were I required to designate the chiefly significant points of contact between studies of the lower primates and practical endeavor toward human betterment, I should name the medical, the sociological, and the psychological. For I am wholly convinced by my own experience as well as by that of others that the various medical sciences and medical practise have vastly more to gain than has yet been achieved, or than any considerable number of medical experts imagine, from the persistent and ingenious use of the monkeys and anthropoid apes in experimental inquiry. Likewise, I am convinced that education and all other forms of social service will profit immeasurably from experimental studies of the fundamental instincts of the other primates and from thorough investigation of the forms of habit formation and of the characteristics of social relations. And last, but not least important, it is safe to assume that our genetic psychology as well as other historical or genetic forms of biological description may be developed more rapidly and satisfactorily by the thorough

study of the monkeys, apes and other primates than by any other means.

It does not seem extravagant to claim that the securing of adequate provision for the systematic and long-continued study of the primates is by far the most important task for our generation of biologists, and the one which we shall therefore be most shamed by neglecting. But it is also a task which, as history clearly indicates, will not be accomplished unless we devote ourselves confidently and determinedly to it, with faith, vision and enthusiasm. For my own part, I am so entirely convinced of the scientific importance and human value of this kind of research that I am willing to devote my life wholly to it.

If we are to progress beyond the present narrow limits of our knowledge of the lower primates and make them contribute importantly to human welfare, it must be through adequate provision for their systematic study. I have presented to my fellow biologists a plan in the hope that their interest, criticisms, and support may ultimately lead to excellent facilities for this work, if not to the realization of the particular plan in question.

Robert M. Yerkes

Harvard University

SCIENTIFIC NOTES AND NEWS

The forty-fifth anniversary of its establishment was celebrated on February 9 by the United States Bureau of Fisheries, with the unveiling of a tablet in memory of its founder, Spencer Fullerton Baird, presented by his associates and followers. Professor Edwin Linton, of Washington and Jefferson College, presented the tablet, and Mr. Edwin F. Sweet accepted it on behalf of the Department of Commerce. The bronze tablet bears a bas-relief of Professor Baird with the inscription:

> He devoted his life to the public service and through the application of science to fish culture and the fisheries gave his country world-wide distinction.

The Albert medal of the Royal Society of Arts has been presented to Sir J. J. Thomson, "for his researches in chemistry and physics and their application to the advancement of arts, manufactures and commerce."

The fifth annual dinner of the Columbia University Biochemical Association took place on February 10, at the Hotel Majestic, with about 250 members and guests present. Dr. A. B. Macallum, professor of physiology at the University of Toronto, was the guest of honor, and made the principal address.

Professor Samuel Wendell Williston, of the department of paleontology at the University of Chicago, has been elected a fellow of the American Academy of Arts and Sciences.

William H. Burr, professor of civil engineering in Columbia University, retires from active service at the close of the present academic year.

At the annual meeting of the Royal Meteorological Society on January 19 the Symons memorial gold medal was presented for transmission to Dr. C. A. Angot, of the French Meteorological Bureau.

Professor Ayres Kopke, of Lisbon, has received the prize offered by the Sociedade de geographia of Lisbon for the best work by a Portuguese writer on sleeping sickness.

The Academy of Sciences at Vienna has granted a further subsidy of $960 to Professor R. Pöch to continue his anthropologic measurements and photographing of the various ethnologic types among the prisoners of war.

The Tri-State Medical Society of Arkansas-Louisiana-Texas has awarded the gold medals for the three best papers on original research work presented to the society, as follows: first prize, Dr. Thomas E. Wright, Monroe, La.; second prize, Dr. Herbert L. McNeil, Galveston, Texas, and third prize, Dr. Truman C. Terrell, Fort Worth, Texas.

The *Journal* of the American Medical Association states that Dr. Richard P. Strong has accepted the position of vice-president to the American International Corporation. This corporation recently formed with a capital of fifty million dollars is designed to explore, purchase or lease, lands and mercantile business in any part of the world. Dr. Strong will

attend to the sanitation districts in which the company's development work is situated.

DR. J. J. TAUBENHAUS, associate plant pathologist of the Delaware Agricultural Experiment Station, has accepted a position of head plant pathologist and physiologist at the Texas Agricultural Experiment Station.

PROFESSOR V. L. KELLOGG, who has been serving as a director of the Belgium Relief Commission in Brussels during the last eight months, has returned to take up his work at Stanford University. His position with the commission is now being filled by Professor Frank Angell.

H. H. WHETZEL, of the department of plant pathology, Cornell University, has gone to Porto Rico to study fungi and plant diseases.

MICHIYA HIRAOKA, professor in the Technical High School of Osaka, and Professor Wakamatsu Yokoyama of Port Arthur, are specializing in mining and metallurgy at the Massachusetts Institute of Technology.

PROFESSOR MILTON J. ROSENAU, of Harvard University, will deliver the Harrington lectures at the University of Buffalo Medical School during the alumni reunion, May 30, 31 and June 1. The subjects will be as follows: Two lectures on "Anaphylaxis" and one on "Education for Public Health Service as a Career."

THE Infants' Hospital, adjacent to the Harvard Medical School, has been formally opened. The speakers were Dr. Charles W. Eliot, president emeritus of Harvard University; Drs. J. Collins Warren, John Lovett Morse and Clarence J. Blake.

M. MAURICE CAULLERY, exchange professor from the University of Paris at Harvard University, has begun in French courses on "The Present State of the Problem of Evolution" and "Biological Problems and Sex."

PROFESSOR L. R. ABRAMS, of Stanford University, has been giving Professor Jepson's course in dendrology at the University of California during the first semester.

A COURSE of six lectures on early American geology is being delivered by Dr. George P. Merrill, head curator of geology, United States National Museum, before the department of geology, Columbia University, on Thursday afternoon at four o'clock and Friday morning at ten o'clock. The purport of the lectures is to show the gradual growth of the science from its infancy to the present day. They are accompanied by lantern slides, portraits, maps, copies of early publications, and personal sketches. There is also in course of delivery before the same department a course of ten lectures on ore deposits by Professor John D. Irving, professor of economic geology, Sheffield Scientific School, Yale University, on Thursday and Saturday mornings at ten o'clock.

PROFESSOR LAWRENCE J. HENDERSON is giving at Harvard University a course of five public lectures on "Teleology and Natural Science."

DR. ARTHUR M. BANTA, of the Carnegie Station for Experimental Evolution, addressed the Sigma Xi of Indiana University on January 27, on "Sexual Forms and the Supposed Reproductive Cycle in *Cladocera*."

AT the 222d meeting of the Elisha Mitchell Scientific Society held at the University of North Carolina on February 7, the program consisted of an address on "The Lumière Process of Color Photography," by Professor E. A. Harrington.

ON February 3, Professor W. H. Bragg delivered before the Chemical Society, London, a lecture on "The Recent Work of X-rays and Crystals and Its Bearing on Chemistry."

A MONUMENT is planned in memory of Professor Angelo Celli. It will stand on the Roman Campagna, where he made his investigations of malaria.

DR. C. WILLARD HAYES, chief geologist of the United States Geological Survey from 1902 to 1911, died on February 9 at his home in Washington, D. C. Dr. Hayes left the survey in 1911 to become vice-president and general manager of the Mexican Aguila Oil Company. He was born in Granville, Ohio, in 1859, and was graduated from Oberlin College in 1883, and in 1887 became assistant geologist of the Geological Survey.

Dr. Richard Henry Whitehead, professor of anatomy and dean of the department of medicine of the University of Virginia, died at his home in Charlottesville, on February 6, after a week's illness with pneumonia. He was in his fifty-first year.

Dr. J. Wilhelm Richard Dedekind, the distinguished mathematician, died at Brunswick on February 2, aged eighty-three years.

Professor Paul Sorauer, of the University of Berlin, known for his work on plant pathology, has died at the age of seventy-seven years.

Dr. Alzheimer, professor of psychiatry at Breslau, died on December 19, aged fifty-two years.

Professor Gross, editor of the *Archiv für Kriminal-Anthropologie,* has died in Graz at the age of sixty-seven years.

Dr. Rodolphe Engel, former professor of chemistry at the Montpellier School of Medicine, has died at the age of sixty-six years.

We learn from *Nature* that Dr. Reginald Koettlitz and his wife have died from dysentery at Somerset, South Africa, where Dr. Koettlitz was in practise. He joined the Jackson-Harmsworth Polar Expedition in 1894 and was senior medical officer in the late Captain Scott's expedition of 1902. In these expeditions and in South America and Africa he had carried on important work of exploration.

William Inchley, lecturer in mechanical and electrical engineering at University College, Nottingham, author of valuable publications on mechanics and heat engineering, was killed on December 19 at the age of thirty-two years, while serving as second lieutenant in the British army.

The *Journal* of the American Medical Association records the following deaths: Tiburcio Padilla, one of the leaders of the profession in Argentina, ex-governor of his province, Tucuman, aged eighty; F. L. von Neugebauer, of Warsaw, noted for his numerous articles on gynecologic subjects but especially for his study and publications on hermaphroditism and allied conditions; L. R. Lorentzen, of Copenhagen, president for a number of terms of the Danish Medical Association, aged sixty-three; M. De Cristoforis, to whose efforts is due in large part the leading place taken by Milan in public hygiene, aged eighty; T. Langhans, until recently professor of pathologic anatomy at the University of Bern, aged seventy-six; A. Mendonça, chief of the bacteriologic institute connected with the medical school at S. Paulo, Brazil, and founder of the *Revista Medica de S. Paulo.*

The University of California has announced a series of Saturday morning lectures, open to the general public on the problems of tropical medicine, a field of work to which particular attention is being paid by members of the staff of the Hooper Foundation for Medical Research of the University of California. These lectures, at the University of California Hospital in San Francisco, are as follows:

January 15—Dr. E. L. Walker, "The Scope of the Literature on Tropical Medicine."

January 22—Professor Walker, "Entamoebiasis," with a clinical discussion by Dr. H. C. Moffitt.

January 29—Professor Walker, "Leishmanioses," with a demonstration of cultures and living organisms.

February 5—Dr. K. F. Meyer, "Trypanosomiases," with a demonstration of living organisms.

February 12—Professor Walker, "Malaria in California," with a demonstration of material.

February 19—Dr. H. C. Moffitt, "Clinical Aspects of Malaria in California."

February 26—Dr. K. F. Meyer, "Piroplasmiases," with demonstrations.

March 4—Dr. H. F. Nichols, "Spirochetiases."

March 11—Dr. Billings, "The More Important Helminthiases."

March 18—Dr. K. F. Meyer, "Yellow Fever, Dengue and Pappataci."

March 25—Dr. K. F. Meyer, "Typhus, Spotted Fever and Verruga Peruviana."

April 1—Dr. Howard Morrow, "Leprosy and Tropical Skin Diseases."

April 8—Dr. Billings, "Beriberi and Pellagra," with demonstrations.

April 15—Dr. E. L. Walker, "Parasitic Insects and the Rôle of Insects in the Transmission of Tropical Diseases."

April 22—Dr. K. F. Meyer, "Tropical Hygiene and Sanitation—Summary of the Present-day Achievements."

PROFESSOR GROSS, editor of the *Archiv fur Kriminal-Anthropologie und Kriminalistik*, has died in Graz at the age of sixty-seven years.

Nature quotes from the *Journal* of the Institution of Electrical Engineers for December 15, 1915, a report of a presentation of original Faraday papers made to the institution by Mr. D. J. Blaikley, whose wife is a niece of Faraday's. Her sister, Miss Jane Barnard, lived for several years with Faraday and his wife as a daughter of the house. She died in 1911, and left these books and papers to Mr. Blaikley to dispose of under certain conditions. They include Faraday's journal of the continental voyage which he undertook, at the age of twenty-two, as an assistant to Sir Humphry Davy—the voyage which, Professor Silvanus Thompson said, in proposing the vote of thanks to Mr. Blaikley, "transformed Faraday from being little more than a bookbinder's apprentice and laboratory assistant of a great chemist, into a man who could speak and think and work scientifically."

A COURSE of twelve lectures by the members of the New York State Museum staff is being given in the Education Building, Albany, as follows:

February 4. "The State Museum: How to Use It." John M. Clarke.

February 11. "Diamonds." H. P. Whitlock.

February 18. "The Forests of New York State." Homer D. House.

February 25. "Lake Albany—Our Present Abode." David H. Newland.

March 3. "Man and Insects." E. P. Felt.

March 10. "How Minerals are Formed." H. P. Whitlock.

March 17. "Mastodons and Elephants of New York." Rudolf Ruedemann.

March 24. "The Empire State of Indian Days." Arthur C. Parker.

March 31. "Harmonics and Cross Purposes in the Insect World." F. T. Hartman.

April 7. "Earthquakes of New York." David H. Newland.

April 14. "Nature Monuments." John M. Clarke.

April 21. "Life of the Ancient Seas." Rudolf Ruedemann.

AT the Chemists' Club, New York City, on February 11, a symposium on "Electrochemical War Supplies" was arranged by the New York Section of the American Electrochemical Society jointly with the New York Sections of the American Chemical Society and the Society of Chemical Industry. Chlorine, hydrogen and many other electrochemical products which were a drug on the market before the war have become valuable. New electrochemical industries like that of metallic magnesium have been started. This whole electrochemical development is of the utmost importance to every chemist and engineer, and to the American nation at large. The speakers were: Lawrence Addicks, "Electrochemical War Supplies"; W. S. Landis, "Air Saltpeter"; E. D. Ardrey (U. S. Navy), "Hydrogen for Military Purposes"; Albert H. Hooker, "New War Products"; William M. Grosvenor, "Magnesium"; G. Ornstein, "Liquid Chlorine"; Geo. W. Sargent, "Electric Steel"; W. R. Ingalls, "Electrolytic Zinc." Dr. L. H. Baekeland, Dr. J. W. Richards, Mr. W. L. Saunders, Mr. E. A. Sperry, Mr. B. B. Thayer, and other engineers consented to be present and express their views.

THE Society of American Foresters, at its annual meeting, held in Washington, on January 22, adopted a resolution endorsing the present federal migratory bird laws.

THE *Journal* of the American Medical Association states that the demonstration train of the State Board of Health started on its initial trip, January 10. The train consists of three Pullman cars, the first of which is used as an office with sleeping and dining accommodation for the demonstrators. The second contains the dynamo, sleeping quarters for the train crew, and various models such as the illustration of the Imhoff tank sewage disposal system; contamination of water in driven or open wells from polluted or service water; a modern dairy; proper feeding and clothing of babies; open-air treatment of tuberculosis and other similar questions of public health. In the third car are displayed thirty-six panel posters

giving warnings and advice on sanitary subjects and disease prevention and a large stereomotograph. On the initial trip the train was in charge of Dr. Joseph Y. Porter, state health commissioner, and Miss F. D. Herndone, his assistant. Surgeon Carroll Fox, U. S. P. H. S., also accompanied the train to inspect health conditions in the state and to observe the workings of this plan of popular sanitary education.

In commemoration of the centennial of the independence of Argentina, 1816–1916, the Academy of Medicine offers a prize of 2,500 pesos for the best unpublished work on a medical subject presented at the Congress of Social Sciences to be held at Tocyman, Argentina, July 9, 1916.

A Vienna manufacturer has given $100,000 to found an institution to study the technical side of nutrition for the people, by correlating the findings of organic chemistry, biology, physiology, etc. It is to be called the Institut für Volksernährung.

The *Journal* of the American Medical Association states that the minister of justice has appointed a commissioner to study crime in Chile and to report to the government his recommendations for measures to prevent crime, reform delinquents, and for the classification and separation of prisoners. A laboratory of experimental psychology is to be established in the penitentiary at Santiago, and physicians in penal institutions will be required to furnish information or data in connection with the work.

For some years the formation of a society and the publication of a journal devoted to applied optics has been under consideration by a number of persons. In November, 1915, such a society, called the Association for the Advancement of Applied Optics, was formed in Rochester. This was so constituted that it might become a local section of a larger society when such should be organized. The officers of the Rochester society are Dr. P. G. Nutting, president; Dr. H. Kellner and Professor Howard Minchin, vice-presidents; Mr. L. A. Jones, recording secretary; Dr. F. E. Ross, corresponding secretary and Mr. Adolph Lomb, treasurer. Since its organization this society has held well-attended, regular meetings every two weeks. The initial organization has shown such strength that it has been decided to proceed at once with the organization of the larger society so that the journal may be started with the next calendar year. A committee on organization is being selected and later, officers and editors will be chosen by ballot. The president and corresponding secretary of the local society will serve as temporary chairman and secretary of the organizing committee. Both may be addressed at the Research Laboratory, Kodak Park, Rochester. A tentative draft of the proposed constitution and by-laws will be submitted shortly for approval.

Nature states that the *Scotia,* which was the vessel that carried the Scottish National Antarctic Expedition to the south polar regions, under the command of Dr. W. S. Bruce, has been burnt in the Bristol Channel, and has been run ashore at Sully. It was hoped at the end of the expedition that the *Scotia* might be further endowed and handed over to the universities of Scotland as a well-fitted oceanographical ship, but this was not to be, and she fell to the hammer as a whaler. Later, however, she was chartered by the Board of Trade as the most suitable vessel on which to carry out ice observation, meteorology and oceanography in the North Atlantic Ocean after the wreck of the *Titanic.*

The Broad Pass region of Alaska, which has long been considered a possible source of mineral wealth, has taken on additional interest since the announcement of the route chosen for the new government railroad connecting the Pacific coast with the interior of Alaska. In anticipation of the probable demand for information about this region the United States Geological Survey began the work of mapping its topography and geology in 1913, and now presents the results of the work in Bulletin 608, by F. H. Moffit, "The Broad Pass Region, Alaska." Broad Pass is the western part of a wide glacial valley which is bordered by steep, straight mountain walls and which lies parallel with a great east-west

range on the north and connects the upper valleys of Chulitna and Susitna rivers. Nenana River, a tributary of the Tanana, occupies the eastern part of the region. The valley of Jack River, which crosses Broad Pass just above the narrow valley of the Nenana, before that stream passes through the Alaska range, provides the route by which the railroad will cross from the Susitna-Chulitna drainage basin to that of the Tanana. The upper parts of streams tributary to Chulitna and Jack rivers overlap each other within Broad Pass, there being no appreciable divide between, so that the grades from the head of the Chulitna to the head of the Susitna are gentle and there is no obstruction. North and south of Broad Pass are high mountains. Those on the north are part of the great range from which, only 70 miles to the west, rise Mount McKinley and, nearby on the east, Cathedral Mountain and Mount Hayes. There is a fair growth of timber in the larger valleys but most of the country is above timber line. This region has long been a favorite hunting ground for the Indians of the Susitna valley. The geologic conditions in the region appear to be favorable to mineralization, but no valuable ore bodies have yet been discovered. The most favorable reports come from the district just west of Broad Pass, near the head of Chulitna River, an important gold placer district, where prospecting has been carried on for several years. Valdez Creek lies about thirty miles east of the pass. Along some of the streams between Broad Pass and Valdez Creek there are prospects of placer gold, which, however, has not been found in commercial quantity. Copper prospects, too, have been discovered in several parts of the region, and at one place, Coal Creek, there is a small area of coal. The railroad, which will probably soon reach this region, will aid greatly in its development. The wealth of the Broad Pass region appears to be mineral rather than agricultural, and it can be profitably exploited only by a greater population and through better means of transportation.

AT the meeting of the Royal Society on November 11 Sir Ronald Ross read an introductory paper on "Pathometry." According to an abstract the method he proposed to follow in studying the nature of the functions according to which the number of individuals infected with some disease should vary from time to time, on the supposition that the laws governing the rate of transference of the considered disease were already known *a priori*. He stated the fundamental problem under consideration in the following terms: "If a population is divided into two groups, namely, those who are affected by some kind of happening, such as an infectious disease, and those who are not so affected; and if in unit of time a constant or variable proportion of the non-affected become affected, while simultaneously a constant proportion of the affected become non-affected (that is, revert or recover); and if at the same time both the affected and the non-affected are subject to different birth-rates, death-rates and rates of immigration and of emigration, so that the whole population may be incessantly varying during the period under consideration; then what will be the number of affected individuals and also the number of new cases at any moment during that period?" In this first paper the problem was presented in mathematical language, with its solution, and a broad analysis of the curves obtained and of some integrals. Only constant rates of happening (applicable to other happenings besides disease), and rates which varied according to the number of individuals already affected (specially applicable to infectious diseases) were considered. In the latter cases the resulting curves were frequently bell-shaped, declining a little more slowly than they rose—that is, generally similar to the curves frequently seen in epidemics—thus suggesting *prima facie* that epidemics might be largely explicable in the terms of the thesis given.

UNIVERSITY AND EDUCATIONAL NEWS

THE General Education Board announces appropriations to colleges as follows: Maryville College, Maryville, Tennessee, $75,000 toward an endowment fund of $300,000; West-

ern College for Women, Oxford, $100,000 toward an endowment fund of $500,000; Milwaukee-Downer College for Women, Milwaukee, Wisconsin, $100,000 toward an endowment fund of $500,000. Including the foregoing, the General Education Board has since its organization thirteen years ago appropriated to colleges $12,322,460 toward a total sum of $57,375,525 to be raised.

The board of trustees of the Carnegie Institute, Pittsburgh, announce the gift of $250,000 from the Carnegie corporation of New York, the money to be used for the purchase of ground north of the present campus.

The formal opening of Alden Hall of Biology of Allegheny College took place on February 4. Dr. W. J. Holland, director of the Carnegie Museum of Pittsburgh, gave the principal address on "Biology, a Cultural and Practical Study." The building is 60 feet by 120 feet, built of gray vitrified brick and terra cotta, with a Spanish tile roof, and is well equipped throughout. Professor C. A. Darling is in charge of the department.

It is stated in *Nature* that the number of undergraduates in residence at Cambridge this term is 665, as against 1,227 during the corresponding term last year, and about 3,600 in a normal term. Amongst the 11,000 members of the university in the land, sea and air services, 1,723 casualties have been notified; 697 have been killed and 892 wounded.

The Berlin correspondent of the *Journal* of the American Medical Association writes that during the semester preceding the opening of the war, 79,077 students (of whom 4,500 were women and about 9,000 foreigners) attended the fifty-two universities and other higher institutions of the German Empire. Of this number 60,943 (4,117 women, 4,100 foreigners) were enrolled in the twenty-one universities; 12,232 (82 women, 2,500 foreigners) were enrolled in the eleven technical schools. The six schools of commerce (Berlin, Cologne, Frankfort, Leipzig, Mannheim and Munich) had 2,625 students, and the four veterinary colleges (Berlin, Dresden, Hanover and Munich) had 1,404 students. The three argicultural colleges had 938 students. Three schools of mining had 668 students, and 267 students were registered in the four schools of forestry. During the first semester following the beginning of the war, the total number of matriculants fell to 64,700 in forty-seven of these institutions. The four schools of forestry were closed, and the veterinary school in Munich became a part of the university. During the winter of 1914–15, about 50,000 of these students were in the field or available for service; that is, 75.75 per cent. of the 66,000 German male students registered at the beginning of the war. Of the 66,000 German male students who were registered at the end of the summer of 1915, only 12,000 are still in attendance at the schools so that about 54,000, or 81.81 per cent., of German higher students are now enrolled in the army. Of the 13,785 university students registered during the summer semester of 1870, only 4,400 (32 per cent.) were at the front, and 3,200 of this number fell in the field.

Dr. Howard E. Pulling has been appointed to an instructorship in plant physiology in the Johns Hopkins University for the current year.

Dr. Robert Lewis, assistant biochemist at the United States Pellagra Hospital, Spartanburg, S. C., has been elected professor of physiology in the University of Colorado.

DISCUSSION AND CORRESPONDENCE

ATMOSPHERIC TRANSMISSION

To the Editor of Science: In Science for December 3, 1915, page 802, line 27, Mr. Very speaks as positively as ever of the diurnal variability of the transmission of the atmosphere and the incorrectness of neglecting its effect in reducing solar constant observations. Does the evidence to the contrary of the observations of September 20 and September 21, 1914, when the sun was observed at Mount Wilson from sun-rise to 10 o'clock, weigh nothing at all with him?[1]

Secondly. In his recent paper on "Earth-

[1] See "New Evidence on the Intensity of Solar Radiation Outside the Atmosphere," by Abbot, Fowle and Aldrich, Smithsonian Miscellaneous Collections, Volume 65, No. 4, 1915.

shine"[2] Mr. Very hangs the merit of his work on the exceptional clearness of August 8 and 9, 1912. It is very singular that these exceptionally clear days occurred when the effects of the dust cloud from Katmai volcano were at their maximum. At various high altitude stations the direct sunlight at high sun was reported to be reduced in August from 10 to 20 per cent., and skylight near the sun in daytime notably increased, yet it is at this very time that the moonlight scattered by the sky near the moon was so exceptionally small at Flagstaff.[3]

Thirdly. Mr. Very, in his paper submitted at Berkeley,[4] argues a high transparency of the atmosphere for the escape of terrestrial radiation, as opposed to the conclusion of Mr. A. Ångström. Very states "that practically all the terrestrial radiation which the atmosphere is capable of absorbing disappears in the first few meters of air traversed by the rays" and hence "the observed nocturnal radiation is a radiation to space," contrary to the opinion of Mr. A. Ångström that only a fraction of it is a radiation to space.

The phenomenon is as follows: A blackened surface at 20° C. is found to give off radiation at a rate of from 0.12 to 0.20 calories per square centimeter per minute when exposed to cloudless night sky. Such a surface would radiate about 0.55 calories if exposed to an enclosure at absolute zero. The question is: Does the nocturnal radiation observed (0.12 to 0.20 calories) represent radiation transmitted almost wholly to space, or is it in a large degree representing merely the radiation of the surface outward minus the radiation of the atmosphere inward? Mr. Very claims that for wave-lengths at which the atmosphere can absorb the rays, its full absorptive effect is produced within a few meters of the radiating surface. Here the temperature is not materially different from that of the surface, and re-radiation of the atmosphere in these wave-lengths approximates that of the black surface according to his view. Mr. Ångström, on the other hand, believes that many of the absorbable rays penetrate far into the atmosphere, where the temperature becomes much reduced, and hence the re-radiation is less than the outgoing radiation because it comes from a source at lower average temperature.

The point at issue is solved if it can be shown that increased length of path, or increased atmospheric humidity, do or do not affect nocturnal radiation. For the evidence see Table IX., p. 63, of A. Ångström's paper, "A Study of the Radiation of the Atmosphere," Smithsonian Miscellaneous Collections, Vol. 65, No. 3. Experiments were made at two stations on the radiation to small parts of the sky at different zenith distances. I refer particularly to observations at Bassour, Algeria, although Mt. Whitney observations support the following conclusions too. Length of path in the atmosphere is shown to be of decided effect. The change from air mass 1 to air mass 3 reduced nocturnal radiation on August 20, 1912, by more than 70 per cent. The result also depends on the degree of humidity prevailing, as is shown plainly by inspection of the whole table. These results show that the whole vertical thickness of the atmosphere is insufficent to absorb "practically all the terrestrial radiation which the atmosphere is capable of absorbing."

C. G. ABBOT

[2] See *Astronomische Nachrichten*, Nos. 4,819–20, 1915.

[3] See in this connection Kimball, "The Effect Upon Atmospheric Transparency of the Eruption of Katmai Volcano," *Monthly Weather Review*, 1913, 41: 153–159, also, "Volcanoes and Climate," by Abbot and Fowle, Smithsonian Miscellaneous Collections, Volume 60, No. 29, 1913; also Kimball, *Monthly Weather Review*, September, 1915, p. 442, in which he shows for Santa Fé, New Mexico, elevation 7,000 feet, that as late as the last half of October, 1912, the mean solar radiation was only 1.37 calories at $z = 48°$, whereas he obtained 1.53 calories as the mean for the corresponding period of 1914.

[4] See *Pop. Ast.*, Vol. 23, p. 648.

UNIVERSITIES AND UNPREPAREDNESS

TO THE EDITOR OF SCIENCE: Some weeks ago an open letter from Professor Stewart Paton appeared in SCIENCE. It was entitled, "Universities and Unpreparedness." It suggested that universities could play an important part

in the solution of the problems raised by the war. It intimated that an increased amount of faculty, in contrast to trustee, government over our universities would contribute to this end. It requested that others who might have ideas on this subject should publish them.

Three points occur to me.

1. If the members of our university and collegiate faculties are given such a part in the direction of the policy of their institutions as Professor Paton suggests, and as Professor J. McKeen Cattell has contended for, they will undoubtedly be much happier and better satisfied with their station in life. With Professor Paton and Professor Cattell this appears to be a theory. For a Yale professor it is not a theory but a fact. For here at Yale professors have, in as full a measure as one could possibly ask the trustees to concede, the power of shaping educational policy and choosing colleagues. As a result we are an unusually contented lot of men. Perhaps we are too contented.

2. Professor Paton is in error I think in believing that this mode of university government makes for progressivism in education. The more people there are who have to be convinced of the wisdom of a new measure, the longer it takes to get the measure adopted. Yale under faculty government is not celebrated for radicalism. The great advances in which Harvard led were effected largely because of the aggressive spirit of President Eliot in support of new ideas. Experience demonstrates that presidents and deans are comparatively easily won over to changes of educational policy and methods. Boards of full professors are far less readily convinced, while general faculties including assistant professors and instructors are usually overwhelmingly dominated by stand-pattism.

3. The principal obstacle to the introduction of the idea of service into the work of our universities is the American college. On the whole our colleges are stronger in funds and prestige than all our professional schools and the other departments of our universities put together. The ideal of the colleges is almost universally that of diffuse culture as opposed to special training. For social reasons their students enter two years older than they should. For no reason that can be justified in utility they are kept for four years. Against every dictate of reason and service they usually work, even under the elective system, in a sort of lock-step which sets the pace for the most earnest by the average or even the indolent.

To develop American education so that it will turn out our young men prepared to be of service in the various highly specialized fields of modern life, the first essentials are to reduce the importance of collegiate education, to give the B.A. degree after two years of work, and to have accepted as part of this work whatever the professional schools want as preliminary training.

I doubt whether there is a sufficiently general comprehension in college faculties of the enormous handicaps which they now place upon professional education to bring about these changes within any reasonable time. Meanwhile a general introduction of arrangements between professional schools and colleges such as those involved in the six-year combined course for the B.A. and M.D. degrees, and similar arrangements for law and engineering, should be encouraged in every possible way.

It is only by the introduction of the vocational motive that collegiate instruction can be made serious, and the student freed from the idea that, as it doesn't matter what he studies in college, it makes no difference whether or not he studies at all.

For those who have no vocational object it might be well to institute a course coordinate with the professional schools, and leading to the degree of C.G.L. or Cultivated Gentleman of Leisure. The materials for it could easily be culled from the present list of academical studies. It would afford the needful university registration for the devotees of athletics, secret societies and other extra-curriculum activities.

Yandell Henderson

Yale Medical School,
New Haven, Conn.,
January 30, 1916

QUOTATIONS

THE ORGANIZATION OF SCIENCE

I WONDER whether other readers of *Nature* besides myself caught the interference fringes from three facets of this glittering subject in the issue of December 2? The first was the Royal Society's advertisement for applications for grants for scientific investigations from the government fund; the second, the editorial contrast between the rates of pay for legal and for scientific services; and the third, the anniversary address of the president of the Royal Society, containing the suggestion that science does not take its place in the national organization because the general public looks upon scientific investigations as a hobby.

What else can the general public do while men of science, in dealing with one another, generally act upon the principle that scientific investigation is a hobby for which facilities are required, not payment? The demonstration afforded by the Government Grant Committee and the Committee of Recommendations of the British Association is conclusive. The normal practise is for these committees to be asked to supply a portion—rarely the whole—of the expenses of some scientific investigation. The applicants in reply to the advertisement will think it meritorious to offer their brains and the time required to use them without asking for any payment. That is the true criterion of a hobby. So great is the power of science to transform serious occupations into hobbies that even lawyers sometimes find themselves astride and ambling with the rest.

In justification of the scientific societies, it may fairly be said that they were intended for the riding of hobbies, and everything in their constitution and practise conforms with that eminently useful ideal. Scientific societies rely very largely upon unpaid work, and long may they continue to do so. One of their chief attractions is that within their precincts there is a respite from the wearing obligations of debit and credit. One can not find the like about a law court or a house of business, where as a rule those who are paid most are treated with the highest respect.

It is the difference between hobby and business that brings us to the parting of the ways. If the national scientific effort is organized through the agency of societies where all the best work, even by the officers, is done without any regard to payment, we can not expect the public to look upon science as a business into which pecuniary considerations enter. It is, and must remain, a hobby. If, on the other hand, there should be created a Privy Council for Science, as Sir William Crookes suggests, there would be at least a permanent staff to whom the idea of paying for brains and time would not be fundamentally repugnant as it must be to the officers of a society.

The idea of scientific investigation as a hobby does not necessarily originate with the general public; it is indigenous in the older universities, where there are a large number of college officials intellectually competent to undertake researches, some of whom do and some do not. At Cambridge in my time scientific investigation was the occupation of the leisure of men whose maintenance was provided by the fees and emoluments of teaching. It was as much a hobby as chess or photography. There was no sense of collective responsibility for providing the nation with answers to its scientific questions. Scientific researches had become an element of competition for rewards of various kinds, and some "research students" were paid; but the idea of "making a living" by scientific investigation never reached the surface, though the merit acquired by research might weigh in the appointment to a post for teaching or administration. On the contrary, the early agitation for the endowment of research was regarded as finally disposed of by calling it the research of endowment, as though the wish to be paid were conclusive evidence of insincerity.

The suggested council will have some difficulty in organizing adequately paid research. The endowed researcher in the national interest must expect an occasional audit of an imperious character, and his employers must see their way to act upon it. With teaching the difficulty is less. If the students of one year do not respond, the next year may be more successful. It takes just about a lifetime to

satisfy ourselves about our own weaknesses. The responsibility is nicely divided; it is just as much the duty of the students to learn as of the lecturer to teach, and neither student nor teacher has the material for a considered judgment upon the matter. That is why the "hobby" system, with occasional rewards for exceptional success, is so popular. It can be worked best by letting things go their own way.

The present state of things, which all agree in deploring, can be altered by drawing a clear distinction between a society's hobbies and the nation's purposes, and entrusting them to separate administrative management. Mr. Carnegie has made it clear that the financial detachment of a voluntary society is not essential to the successful organization of scientific research.—F. R. S. in *Nature*.

SCIENTIFIC BOOKS

Studies in Edrioasteroidea. I.–IX. By F. A. Bather. Published by author at "Tabo," Marryat Road, Wimbledon, England, October, 1915. Pp. 136, 13 plates. Price 10s.

This book by the well-known authority on echinoderms contains a series of articles that were published from 1898 to date in the *Geological Magazine,* but of which no separata were distributed because the plates were lost while in store. In consequence of this unfortunate circumstance several authors, the present writer among them, have become guilty of ignoring important results of Dr. Bather's studies.

The earlier papers contain elaborate descriptions of all known Edrioasteroidea based on so careful preparation of specimens that months were spent in several cases in cleaning a single specimen. By this method the finest details, notably in our North American *Edrioaster bigsbyi,* were brought out, such as the hydropore and the small plates of the periproct. Three new genera are distinguished, but most important are the three concluding articles, published in 1915, which contain the morphology and bionomics of the Edrioasteroidea, a comparison of their structure with that of the Asterozoa, and a discussion of the genetic relations to other Echinoderms. In these chapters Dr. Bather not only succeeds in demonstrating much closer resemblances between these early pelmatozoans and the Asteroidea than were hitherto suspected, but also in tracing the probable course of derivation of the Asteroids from the Edrioasteroidea. These conclusions give the work a distinctive value for all students of phylogeny.

The book is finely illustrated with diagrams and a dozen plates of good photographs and very lucid drawings.

Rudolf Ruedemann
New York State Museum

SPECIAL ARTICLES

ADAPTABILITY OF A SEA GRASS

While dredging during July, 1915, in the Gulf of Mexico near the Dry Tortugas on the Carnegie Institution's yacht, *Anton Dohrn,* the writer's attention was attracted to two comparatively rare plants. These plants, which are species found only in the western hemisphere, were remarkable not only for their curious and interesting morphology, but rather for the unusual conditions under which they were found growing. Although spermatophytes, these plants came up in the dredges with marine algæ from a depth of sixteen to eighteen fathoms, *i. e.,* ninety-six to a hundred and eight feet. The algæ associated with them were the usual species found in those waters, viz., *Caulerpa, Halimeda, Penicillus, Codium, Udotea, Acetabularia,* etc. Bottom samples taken with a clasper on the sounding instrument showed the Gulf floor here to consist of a fine white mud composed of calcareous débris such as broken corals, molluscan shells and echinoderm tests.

All the plants were carefully picked out of the miscellaneous material which came up in the dredges and preserved. These on being later brought north were identified by the writer as two species of *Halophila* du Petit Thouars, and the only members of the genus, as remarked above, to be found in North or South America, and belonging in the order Hydrocharitales. A brief description of these two species is given as they have a limited range in the tropical waters of the western

hemisphere; the smaller particularly has been collected at only a few stations in the West Indies.

The larger and more widely distributed is *Halophila Engelmanii* Aschers. It is a delicate plant creeping over the muddy bottom and rooting at the nodes by white fibrous roots. The leaves are very short petioled, serrate and produced in whorls or clusters, so accurately described by Bailey Balfour[1] for *H. stipulacea* (Forsk.) Aschers., which he found on the island of Rodriguez in 1874. The plants are dicœcious with axillary inflorescence. Small,[2] who has collected the species in the Florida Key region, says the flowers and fruit have not been seen; however, the author collected pistillate flowers and ripe fruits in abundance in all the dredges in which the plant came up. The flowers are invested in a bibracteate axillary spathe on a short pedicel. The original description of the species by Ascherson[3] is rather vague as to the flowers since he classified the species largely by the leaves and Bentham and Hooker[4] give the species a casual and somewhat doubtful treatment. A great many of the older writers on the genus in describing the flowers of *Halophila* mistook the pistil with the hypanthium to be all pistil, and what are the true styles to be long stigmas, thus completely overlooking the perianth. The pistillate flower really consists of a small flask-shaped ovary, sessile in the spathe formed by the two bracts and prolonged into an elongated hypanthium, 3 mm. in length, on top of which is the three-parted perianth. This species, although it has not been figured in any works so far as the writer's knowledge goes, does not differ materially from *H. stipulacea* (Forsk.) Aschers., found in the Indian Ocean and described with such elaborate and careful drawings by Balfour,[5] except that the stipular bracts at the nodes are lacking.

H. Baillonis Aschers., the other and smaller species found in the dredging operations, is the only one in the genus that is monecious. Early writers suspected the monecism of this species, but Holm's[6] work on the species confirmed the suspicion. Holm's work also has been very careful and accurate, but his plates do not show the peculiar arrangement of the staminate and pistillate flowers lying in such close proximity in the spathe as to suggest self-fertilization. Close pollination, however, does not seem to be of general occurrence in the genus. In appearance *H. Baillonis* Aschers. resembles very much *H. ovalis* (R. Br.) J. D. Hook, which is the most widely distributed species in the genus occurring throughout the Indian Ocean and South Sea, except that *H. Baillonis* is monecious and has serrated leaves.

The fertilization of *Halophila* has never been actually seen, but the researches of both Balfour and Holm on the morphology of the anther and pollen have led to the supposition that the manner of fertilization is similar to that of *Zostera marina* as observed by Clavaud[7] and Engler[8] except that in the latter plant the pollen grains individually are elongated cylindrical bodies, while the pollen of *Halophila* occurs in the anther sacs in coiled, spiral chains, the pollen grains adhering to each other by a mucilaginous substance. These chains are carried from the proterandrous staminate flowers to the long filiform styles of the pistillate flowers in other spathes by the water current, the chains getting entangled on these styles and fertilizing the ovules.

However interesting the structure of these lowly submerged plants may be, the peculiar conditions under which they were found grow-

[1] Balfour, B., "On the Genus *Halophila*," *Trans. Bot. Soc.*, Edinburgh, XII., pp. 290–334, 1879.

[2] Small, J. K., "Flora of the Florida Keys," New York, 1913, p. 5.

[3] Ascherson, P., "Neumayer Anleit. zu Wissen. *Beobacht. auf Reisen*," 1857, p. 368.

[4] Bentham & Hooker, "Genera Plantarum," f. III., p. 435.

[5] Balfour, *loc. cit.*

[6] Holm, Th., "Recherches anatomiques et morphologiques sur deux Monocotyledones Submergeés," *Bihang. till. K. Svenska. Vet.- Akad. Handlingar*, Bd. 9, No. 13, 1885.

[7] Clavaud, Armand, "Sur le veritable mode de Fecondation du Zostera marina," *Ann. Soc. Linn. Bordeaux*, p. 109, 1878.

[8] Engler, A., *Botan. Zeit.*, p. 654, 1879.

ing give them still further interest and help to confirm an idea recently expressed by T. W. Vaughan[9] in his geologic research on the origin of the islands in the waters in which these species of *Halophila* grow, viz., that South Florida and the adjacent Keys have undergone a recent depression. The material of which these islands is formed was deposited in Pliocene times, this material being contributed by various agencies, coral reefs and calcareous mud precipitated by denitrifying bacteria, etc. The land thus formed suffered a series of oscillations which Vaughan tabulates and which the writer here reproduces from Dr. Vaughan's paper.

Oscillations of South Florida

Recent—	Uplift.
	Depression (modern reefs).
Pleistocene—	Depression (Pleistocene reefs, part of which stood as much as 18 feet above sea level).
	Uplift.
Pliocene—	Depression (some coral reefs but no well-developed reefs).

Vaughan says in part concerning these movements:

> Pliocene deposition was followed by uplift which was succeeded by depression during the Pleistocene subsidence along a curve from the eastern side of Biscayne Bay, first trending south and then bending west, a barrier coral reef flourished, separated by a channel from the main bank on which the Miami oolite was forming or had formed in strongly agitated waters. West of the coral reef, on an extensive flat in shoal water, the Key West oolite was formed, while still further to the westward the Tortugas were outlined under the influence of water and currents.
>
> This period of events was succeeded by the elevation of the entire key region to more than fifty feet above its previous level. This uplift was succeeded by a depression, lowering the surface thirty feet or more, establishing the same relation of the sea level to the land that now prevails. Subsequent to the beginning of the last depression the present barrier reef has developed seaward of the keys on a platform already prepared for it, the Marquesas have been formed by winds and currents and coral reefs have reestablished themselves in the Tortugas.

From this it is seen that the land in the region in which these two species of *Halophila* have been collected has in Recent times undergone a considerable depression. The writer therefore assumes that these plants grew, in earlier times, in much shallower water and in depths at which they are more generally found to-day. Small[10] mentions the genus as occurring in "shallow water," Balfour collected *H. ovalis* on Rodriguez on the reefs surrounding the island "on shoals just uncovered at low water" and *H. stipulacea* in "slightly deeper places where it is submerged." Baron d'Eggers,[11] who collected *H. Baillonis* Aschers. in Saint Thomas harbor, says:

> The plant grows in coarse sand at a depth of two to four fathoms, here and there.

The habitat of *H. Beccarii* Aschers., too, has been well described by Beccari[12] himself in his book, where he says:

> Toward dusk on the bank of the Bintulu I caught some curious crustaceans and a small water snake. It was only after I had been wading about for some time that I discovered that the soft substance under my feet was not mud but a sheet of vegetation composed of a minute submerged plant hidden by a thin layer of fine slush so that it was not easily distinguished at first. I afterward found that in some places it was uncovered and quite exposed.

From these references it is seen that the genus is usually found in comparatively shallow water. The sea grasses in general, according to Ascherson,[13] are found in depths not over ten meters but Lorenz[14] reports *Posidonia Oceanica* (L.) Del. as occurring in the Gulf of Quarnero at a depth of eighteen to thirty-

[9] Vaughan, Thomas Wayland, U. S. Geological Survey, "Building of the Marquesas and Tortugas Atolls and A Sketch of the Florida Reef Tract," Pub. No. 183, Carnegie Inst. of Wash., D. C., 1914.

[10] Small, J. K., *loc. cit.*

[11] d'Eggers, Baron, "Flora of St. Croix and the Virgin Islands," *Smithson. Inst. Bull. Nat. Mus.*, No. 13, p. 98, Wash., D. C., 1879.

[12] Beccari, Odoardo, "Wanderings in the Great Forests of Borneo," London, p. 262.

[13] Ascherson, P., *loc. cit.*

[14] Lorenz, Th., "Physik. Verhältnisse und Verteilung der Organismen im Quarn Golfe," p. 249, Wien, 1863.

five fathoms, that is, thirty to fifty meters; however, Ascherson regards this as the extreme limit for plants of this type and possibly this depth has never been reported elsewhere.

That the two species of *Halophila* described above may have been growing in these Florida waters in Pleistocene times or even an ancestral type of *Halophila* we can have no means of ascertaining, but taking into consideration the clarity of the water at present and the ease with which light can penetrate it, it is not unreasonable to suppose that enough light can be secured by the assimilative tissues of the plants for photosynthetic activities at great depths. Now even though the plants experience some difficulty in their synthesis due to a lessened intensity of light, a change so gradual as the depression of a great area of sea bottom would seem to give a plant belonging to so plastic a group as the Hydrocharitales an ideal opportunity to react to the changing environment.

To summarize briefly, then, the occurrence of these two species of *Halophila* at an unusual depth, probably illustrates the adaptability of the genus and supplements the geological evidences for a depression of the Florida key region. In conclusion the writer wishes to express his gratitude to Professor Van Ingen, of Princeton, for suggesting that these observations might be of general interest.

HOWARD H. M. BOWMAN
UNIVERSITY OF PENNSYLVANIA

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SPECIAL MEETING[1]

IT will be remembered that the Council of the American Association for the Advancement of Science at its Columbus, Ohio, meetings held from December 27, 1915, to January 1, 1916, voted to permit the association to hold a special meeting on January 3 and 4, 1916, in Washington as an indication of the interest of the association in the meetings of the Second Pan-American Scientific Congress which were held in Washington from December 27, 1915, to January 8, 1916.

[1] Held on January 3 and 4, 1916, in cooperation with the Second Pan-American Scientific Congress.

The opening meeting was held on Monday night, January 3, in the Memorial Continental Hall and was largely attended by members of the association and by delegates to the Pan-American Congress.

Dr. R. S. Woodward, past-president of the American Association, presided and introduced Mr. John Barrett, director general of the Bureau of American Republics and secretary general of the Second Pan-American Scientific Congress, who made an address of welcome as follows:

"I consider it a great honor and privilege to say a word this evening. While I may not be classed as a scientist in the same way as we would classify Dr. Campbell and Dr. Woodward, I can frankly say that I have learned more during the past ten days about the science of international congresses than I ever dreamed could be discovered in a lifetime.

"Speaking as the Secretary General of the Second Pan-American Scientific Congress, I extend to you all congratulations upon the holding of this joint session of the American Association for the Advancement of Science and the Second Pan-American Scientific Congress. I bring to you from the latter an expression of profound interest in what your organization is achieving and we feel flattered that you should have arranged this special meeting.

"It may interest you to know that this Second Pan-American Scientific Congress is the largest official international gathering which has ever assembled in the history of the national capital, and, at the same time, the largest Pan-American official gathering which has ever been called together in any capital of the Western Hemisphere. It is indeed fortunate, moreover, that it should meet at this remarkable time in the world's history, when the harmonious meetings and discussions of the representatives of the twenty-one American Republics should stand out so strongly in contrast to the divided conditions of Europe. The silver lining of the European war cloud, if its terrible blackness can have any such brightness hidden in its folds, is the development of Pan-American solidarity, Pan-American community of interest and Pan-American friendship and peace.

"It is also most appropriate that we should now have a great Pan-American scientific assembly. Last May there met in Washington a Pan-American Financial Conference that attracted the attention of the world. Through many years we have had Pan-American political and commercial con-

gresses and conferences and now we hold in Washington a Pan-American intellectual congress which, in some respects, is more important than all the others.

"Ideal Pan-Americanism can only be achieved through cooperation in science, in education and in intellectual effort as well as in finance and commerce. Particularly is this true of the relations of the United States with the Latin-American countries, where so much attention and prominence are given to science and education.

"The American Association for the Advancement of Science is as well known throughout Latin America as it is in the United States and I am gratified to see so many of the Latin-American delegates here to-night to manifest their interest in this meeting and to give a worthy hearing to Dr. W. W. Campbell, director of the Lick Observatory and president of the association. It is also a pleasure to note that you are to be briefly addressed by Dr. Ernesto Nelson, Inspector General of Education of the Argentine Republic and a member of the Argentine delegation to the Pan-American Scientific Congress. I have known him for many years and can assure you that he stands in the forefront of the educators of South America. I am always glad, moreover, to assist at any gathering presided over by my friend, Dr. Woodward, who is your past-president and also a member of the United States delegation to the Pan-American Scientific Congress."

Dr. Woodward then called upon Dr. Ernesto Nelson, director general of Secondary Industrial and Commercial Education, Buenos Aires, Argentina, and Commissioner of Education, Panama-Pacific International Exposition, who addressed the meeting on behalf of the Latin-American delegates to the Scientific Congress. Dr. Nelson's remarks were as follows:

"As a member of the Latin-American representation to the Second Pan-American Scientific Congress, I have been invited to welcome you to-night to the American Association for the Advancement of Science. My presence here, therefore, emphasizes the delightful spirit of internationalism which characterizes scientific activities where no international boundaries exist.

"In these days, when we are busy telling one another how much stranger we are to each other, how much we have neglected to buy of or sell to each other, it is only fitting that we should also meet on a field on which we can recognize one another as old acquaintances; on a field in which considerable cooperation has been taking place steadily and inconspicuously. I refer not only to the fact that science is a common good, a merchandise whose importation is subjected to no duty and is not dependent upon treaties to gain possession of markets, but to the fact that, through the efforts of agencies like the Carnegie Institution, the universities of Harvard, Leland Stanford, Michigan, Princeton, to say nothing of American museums, a successful work of scientific cooperation is helping to make Americans at large better acquainted with each other.

"The fact that we have come here to-night with our minds prepared to learn heavenly things gives me particular pleasure to recall that it was one of the most illustrious members of the American Association for the Advancement of Science, Dr. Benjamin Apthorp Gould, of Cambridge, Mass., who started in Argentina the work of cataloguing the stars of the Southern Hemisphere, a work which, since then, has enlisted American men of science to the extent that to-day the observatory of the University of Michigan and that of La Plata in Argentina are practically a single institution, carrying a perfectly coordinated work under the same head.

"I am aware that science alone does not make civilization, although it is the chief ingredient of it; but I do believe, as you all believe who are here, that science is the human activity that most surely helped in bringing about mutual understanding among different peoples. We may feel differently, we may act differently, but we must, necessarily, seek truth along the same lines and have the same attitude before scientific facts.

"Let me conclude, therefore, by hoping that, as time goes on, further and further opportunities of quiet scientific cooperation will present themselves before the learned men of the three Americas."

The main feature of the evening was the address by Dr. William Wallace Campbell, director of the Lick Observatory of the University of California and president of the American Association, on the subject of the "Evolution of the Stars." This was a beautifully illustrated address covering for the most part the Hale lectures by Dr. Campbell, given before the National Academy of Sciences and printed in *The Popular Science Monthly* for September, 1915, and *The Scientific Monthly* for October, November and December, 1915.

The meeting concluded with interchanges of courtesies between the members of the American

Association and the delegates to the Scientific Congress.

On Tuesday, January 4, 1916, two sessions of the association were held in the large lecture room of the U. S. National Museum—the first at 10 A.M. and the second at 2 P.M. President Campbell presided.

Abstracts of the papers presented are as follows:

Some Phases of the Origin and Evolution of the South American Fresh-water Fishes: CARL H. EIGENMANN.

The freshwater fish fauna of tropical America is very rich in species. It is entirely distinct from the fauna of Patagonia to the south of it and to the fauna of North America. The fishes of Patagonia have their nearest relatives in Australia and New Zealand. The tropical fauna does not extend south of the La Plata basin. In degrees of latitude it extends much further south of the equator than north of it. Northward it has filtered into western Colombia and thence through Panama into Central America, Mexico and in representatives of two genera into the southern United States and Cuba.

The tropical American fauna has its nearest relatives in Africa, while many of the elements of Africa and South America may be leftovers from faunas formerly extending over much larger portions of the globe, or may have been independently derived from the ocean. The Characidæ and the Cichlidæ seem to demand fresh waters for their migration from place to place. Inasmuch as these families are not found in Europe and evidently only intrusively in the southern United States and Mexico they seem to demand the presumption of a former land bridge or land wave connecting South America and Africa.

Aside from minor expeditions several notable expeditions collected fishes in various parts of South America during the last century. Between 1817 and 1820, Spix and Martins collected in eastern Brazil. John Natterer, between 1817 and 1835, collected in Brazil from Rio de Janeiro to Cuyaba, down the Guapore and Madeira and in the Rio Negro. In 1843, Castelnau made an extensive journey through South America. All of these expeditions were "Natural History" expeditions and devoted as much or more time to other things as they did to fishes.

In 1865, Louis Agassiz led the Thayer expedition to Brazil and devoted over a year, with numerous assistants, primarily to the collection of fishes. During the current century, Mr. John Haseman traveled more extensively than any other expeditions in Brazil, Uruguay, Argentina and Paraguay and devoted himself almost exclusively to the fishes. The present speaker collected fishes in British Guiana and Colombia while Charles Wilson collected in western Colombia, Mr. Arthur Henn in western Ecuador and Messrs. Meek and Hildebrand in Panama.

The fish fauna of tropical America consists of many intrusives from the ocean, like the stingaree, the flounders, the puffer and various sciænids. Of a few relicts, like *Osteoglossus* and *Lepidosiren*, of Cichlids, Pœcilids and an abundance of catfishes and their relatives, the Loricariidæ, and Callihethyidæ, etc., and above all, a host of Characids which have paralleled, both in habits and in form, most of the other freshwater fishes of the world.

Botanical Explorations in South America: JOSEPH NELSON ROSE.

Dr. Rose gave an account of his two exploring trips to South America, the first one being on the west coast, when Peru, Bolivia and Chile were explored, and the second one being on the east coast, in Brazil and Argentina. He called attention to the need for natural history exploration in South America and the unusual opportunities for the carrying on at the present time of this work by naturalists from the United States. He spoke of the kindly feeling shown by the South American scientists, and their willingness to assist him in his work, and of their interest in scientific work generally as carried on by the institutions of this country.

Mention was made of the interesting biological problems awaiting investigation, and of the fact that many new plants and animals are being found by collectors, and that there is great need of a restudy of the species already described.

Dr. Rose stated that North American collections, especially of plants, unfortunately contain very poor representations of South American material.

The various cactus deserts of South America were described, special attention being called to the remarkable display of epiphytic cacti which are to be found in the region of Rio de Janeiro.

The lecture was illustrated by lantern slides showing the desert and mountain types of vegetation.

The Distribution of Bird Life in Colombia: A Contribution to a Biological Survey of South America: FRANK M. CHAPMAN.

In conformance with a plan for zoological exploration designed eventually to cover all of South America, the American Museum of Natural History began, in 1910, field work in Colombia. Since that time, eight expeditions have been sent to that country and thousands of specimens of birds and mammals and pertinent information in regard to the country they inhabit have been secured. The identification of this material having now been nearly completed data are for the first time available to determine the life-zones of the Colombian Andes and the faunal areas of each zone. Four zones can be defined with surprising definiteness: A tropical, extending from sea-level to approximately 5,000 feet; a subtropical, extending from 5,000 to 9,000 feet; a temperate, extending from 9,000 to 12,500, or the upper limit of tree-growth, and an alpine or Paramo zone, extending from the timber line to the lower limit of snow, or approximately 15,000 feet.

Having determined these zones on the basis of collections and field studies, the investigator is now prepared to consider the problem of their faunal areas and of the origin of the forms occupying the zones above the basal or tropical zone. A detailed report on these and allied questions, together with an outline of the distribution in Colombia of each of the over 1,300 species and subspecies of birds secured is now approaching completion.

General Aspects of Zoological Exploration in South America: Wilfred H. Osgood.

Zoological exploration with particular reference to the higher vertebrates has to-day a greater significance than even a very few years ago. Aside from the increased importance it has owing to its reciprocal relations with advances in other sciences than zoology, it differs from earlier work in that it follows a definite plan and applies itself consistently to a particular region. Moreover, methods of preserving specimens and keeping records are such that the subsequent study of the material has infinitely greater possibilities than formerly. It is evident also that results rapidly become cumulative, for as collections grow larger and more comprehensive the problems on which they may be brought to bear become broader and more far reaching.

Until recently, knowledge of the fauna of South America has depended upon scattered data gathered sporadically and variously isolated in different parts of the world. Detailed systematic study and explorations continued over a period of years opens up a host of problems not only in classification and distribution, but also in phylogeny, ecology, evolution and relations to human affairs. Especially in the study of mammals there is a wide field promising important results. No general work in the mammals of South America has even been attempted and there is scarcely a single genus of which the geographic distribution is known in detail. Ignorant of the facts of distribution, we are of course still far from a knowledge of their causes. Among problems of great interest are those dealing with the derivation of the fauna and recent work is throwing considerable light upon the relations of living and extinct types. From the economic standpoint, faunistic work in South America may prove to be of even greater importance than it has been in northern countries, as for example in the control of disease and in the advance delimitation of regions naturally suited for agricultural development.

The Corals and Coral Reefs of the Gulf of Mexico and the Caribbean Sea: Thomas Wayland Vaughan.

After calling attention to the three bathymetric zones represented by the corals in coral reef areas, the factors which determine the locus of corals of different growth facies in the shoal waters of such areas were indicated. The discussion of the factors determining the lower bathymetric limit of shoal water corals included an account of the relative capacity of corals to remove sediment from their surfaces, their mechanisms for catching food, the nature of their food and their relations to light and to temperature. The relations to salinity and atmospheric exposure were considered. Experiments on rearing corals, on the determination of the length of the free-swimming larval stage and on the growth rate of corals were described.

The relations of off-shore reefs to the submarine platforms around the Gulf of Mexico and the Caribbean Sea, viz., Mosquito Bank, Compeche Bank and the Floridian Plateau, and to the submerged terraces of the Virgin Islands, the Saint Martin Plateau and Antigua, were briefly discussed. It was shown that in Recent geologic time the margins of the Gulf of Mexico and the Caribbean Sea have been submerged by the sea overflowing the marginal land areas, which in Pleistocene time stood higher with reference to the sea-level than at present. Of the living off-shore reefs those of the continents have grown up on recently submerged or more deeply submerged

portions of the continental platforms, while those off the islands are growing upon submarine terrace flats which either stood above water level previous to the last submergence or which have undergone deeper submergence in Recent geologic time.

The Distribution of Igneous Rocks in South America: HENRY STEPHENS WASHINGTON.

The paper presented a very brief correlation between the distribution of petrographic provinces in North and South America. Our knowledge of the chemical petrography of the southern continent is very imperfect, but suffices to give some approximate ideas of some of the main features.

The lavas of the long line of huge Andean volcanoes belong, almost without exception, to very common and widely distributed types, dacites, andesites and basalts, which are, chemically, clustered around the average igneous rock, without prominent dominance of any one chemical constituent. These correspond to, and are a continuation of, the volcanic rocks of the Rocky Mountains and the Cordilleras, from Alaska to Panama. The central part of South America is scarcely known, but here, as in North America, there would seem to be few igneous rocks. Near the east coast, as in Brazil and Paraguay, are highly sodic rocks, corresponding to a similar zone parallel to the east coast of North America, from Ontario to Texas. There are also some indications in Brazil of rocks of a very distinct chemical type, like some found in Ellesmere Land, Ontario and New York. It would appear, therefore, that the two continents much resemble each other in the general distribution of the igneous rocks.

L. O. HOWARD,
Permanent Secretary

THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

THE third annual meeting of the Federation formed by the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics and the American Society for Experimental Pathology, was held in laboratories of the Harvard Medical School, Boston, on December 27, 28 and 29, 1915.

Only two joint sessions could be arranged, the large number of papers offered and the limited time forbidding other combined meetings. The first one was held on Monday morning, December 27, and this session opened the scientific meetings. The following papers were read and discussed:

Symposium: "Food Accessories." Discussion opened by T. B. Osborne and L. B. Mendel, E. V. McCollum, Carl Voegtlin.

"The Formation and Structure of the Fibrin-Gel," by W. H. Howell.

"Experiments on the Mechanism of Osmosis," by Jacques Loeb and Hardolph Wasteneys (by invitation).

"Further Observations on Over-activity of the Cervical Sympathetic," by W. B. Cannon and R. Fitz (by invitation).

"Some New Observations on the Uric Acid Content of the Blood," by Otto Folin and R. D. Bell (by invitation), with the assistance of G. Le B. Foster.

"On Continuous Insufflation Through the Humerus in Fowl," by A. L. Meyer (by invitation) and S. J. Meltzer.

"The Influence of the Adrenals on the Kidney," by E. K. Marshall and D. M. Davis (by invitation).

"Heredity and Internal Secretion in the Origin of Cancer in Mice," by Leo Loeb.

"The Effect of X-Rays on Cancer Immunity," by James B. Murphy.

"The Presence of Posterior Lobe Secretion in the Cerebro-spinal Fluid," by Harvey Cushing and Gilbert Horrax (by invitation).

The second joint session took place on Tuesday afternoon, December 27, and was devoted entirely to demonstrations. These demonstrations were given partly in a large amphitheater and partly in three laboratory rooms. The program was as follows:

DEMONSTRATIONS

"Demonstration of the Agglutination of Bacteria in Vivo," by Carroll G. Bull (by invitation).

"A Method of Obtaining Suspensions of Living Somatic Cells of the Higher Animals," by Peyton Rous and F. S. Jones (by invitation).

"Analogous Antagonistic Effects Exerted by Electrolysis and Anesthetics on Physical Systems and Living Cells," by G. H. A. Clowes.

"The Action Current of Glands," by W. B. Cannon and McKeen Cattell (by invitation).

"A New Type of String Galvanometer and Accessory Apparatus," by Horatio B. Williams.

"Apparatus for the Investigation of Cardiodynamics," by Robert Gesell.

"A Circulation Model," by A. L. Prince (by invitation).

"An Improved Slide for Blood Counting," by Theodore Hough.

"A Motor-driven Airblast Interruptor for Artificial Respiration," by W. B. Cannon.

"A Mine Rescue Breathing Apparatus," by Yandell Henderson.

"A Method of Studying Respiration in the Rat," by H. G. Barbour and L. L. Maurer (by invitation).

"Insufflation Through the Humerus in Fowl," by A. L. Meyer (by invitation), and S. J. Meltzer.

"A Simplified Procedure for the Determination of Carbon Dioxide Tension in the Alveolar Air," by W. McK. Marriott.

"A Quantitative Pump for Prolonged Intravenous Injections," by R. T. Woodyatt.

"Some New Apparatus," by D. E. Jackson.

"Apparatus for Recording Graphically the Movements of Melanophores," by Raymond Spaeth (by invitation).

"Further Studies on the Elective Localization of Streptococci," by Edward C. Rosenow.

"The Perfected 'Shadow Pupillometer,'" by George W. Fitz.

"A Simple Rheostat for Laboratory Use," by E. G. Martin.

"A Motor-driven Circuit Breaker," by E. G. Martin.

Executive Committee for the Year 1916: Chairman, Simon Flexner, secretary, Peyton Rous, for the Pathological Society; W. B. Cannon and C. W. Greene, the Physiological Society; Walter Jones and Stanley R. Benedict, the Biochemical Society; Reid Hunt and John Auer, the Pharmacological Society.

The next annual session of the Federation will be held in New York City, together with the American Association for the Advancement of Science.

J. Auer,
Secretary of the Executive Committee, 1915
Rockefeller Institute

THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

The seventh annual session of the Pharmacological Society was held in Boston at the Harvard Medical School on December 27, 28 and 29, 1915. Three sessions were independent and two were joint meetings with the other members of the federation.

The scientific sessions were opened on Monday morning, December 27, in accordance with custom, by a joint session of the four societies forming the federation. The papers read at this meeting will be found in the preceding account of the federation.

The first independent session was held on Monday afternoon and the following papers were read and discussed:

"The Effect of Drugs on Auricular Systole and Their Consequent Effect on Ventricular Efficiency," by C. J. Wiggers.

"A Study of the Potency of Digitalis Preparations," by J. H. Pratt and C. Wesselhoeft (by invitation).

"The Influence of Iodine on the Heart," by Wm. Salant and A. E. Livingston (by invitation). (Read by title.)

"The Effect of Certain Drugs on the Excised Uterus in Guinea-Pigs," by J. D. Pilcher.

"The Stability of the Growth-promoting Substance in Butter Fat," by Lafayette B. Mendel and T. B. Osborne.

"Studies on Lipoids," by W. H. Schultz. (Read by title.)

"Further Studies on Mustard Oil Inflammation," by S. Amberg, A. S. Loevenhart and W. B. McClure (by invitation).

"The Distribution of Trypan-red to the Tissues and Vessels of the Eye as Influenced by Congestion and Early Inflammation," by P. A. Lewis.

"Is the Pupil Dilatation from Adrenalin Following Gangliectomy Due to the Vasodilatation?" by T. S. Githens and S. J. Meltzer.

"The Absorption and Elimination of Different Dyes," by Wm. Salant and R. O. Bengis (by invitation). (Read by title.)

The second independent session was held on Tuesday morning, December 28, and the following papers were read and discussed:

"The Inhibition of the Toxicity of Anesthetics in the Nephropathic Kidney," by Wm. de B. MacNider.

"Morphological Changes in the Tissues of the Rabbit as a Result of Reduced Oxidations," by G. H. Martin (by invitation), C. H. Bunting and A. S. Loevenhart.

"Relation of the Hemolytic Power to the Surface Tension of Saponin Solutions," by E. Woodward (by invitation), and C. L. Alsberg. (Read by title.)

"Further Study of Nicotin Tolerance," by C. W. Edmunds and M. I. Smith (by invitation).

"Effects of the Prolonged Feeding of Aluminum," by George B. Roth and Carl Voegtlin.

"The Toxicity of Various Commercial Preparations of Emetin Hydrochloride," by L. G. Rowntree and R. L. Levy (by invitation).

"Further Observations on the Clinical Actions of Veratrum," by R. J. Collins (by invitation).

"The Detoxifying Action of Sodium Salts upon Potassium Salts on Intravenous Injection," by S. Amberg and H. F. Helmholtz.

"The Influence of Temperature on the Onset of Strychnine Convulsions in the Intact Frog," by B. H. Schlomowitz (by invitation) and C. S. Chase (by invitation).

"On the Action of Epinephrin and Papaverin on the Ureter," by David I. Macht (by invitation). (Presented by J. J. Abel.)

The third independent session was held on Wednesday morning, December 29, the Tuesday afternoon meeting being a joint session of the federation.

The following papers were presented and discussed:

"Salicyl in Blood and Joint Fluid of Individuals Receiving Full Therapeutic Doses of Salicylate," by R. W. Scott (by invitation), T. W. Thoburn (by invitation) and P. J. Hanzlik.

"Excretion of Salicyl in the Urine of Rheumatic and Non-Rheumatic Individuals," by R. W. Scott (by invitation), T. W. Thoburn (by invitation) and P. J. Hanzlik.

"Some Observations on the Elimination of Hexamethylenetetramin (Urotropin)," by K. George Falk and K. Sugiura (by invitation).

"Some Observations on Anesthesia and Analgesia," by D. E. Jackson.

"Paraoxyphenylethylamin as a Morphin Antagonist," by H. G. Barbour, L. L. Maurer (by invitation) and W. C. v. Glahn (by invitation).

"Action of Some Derivatives of Phenylethylamin," by H. G. Barbour.

"The Comparative Action of the Chief Alkaloids of Cinchona," by Worth Hale.

"The Fate of Sodium Citrate in the Body," by Wm. Salant and L. F. Wise (by invitation). (Read by title.)

"Further Studies on the Pharmacological Action of Oil of Chenopodium," by Wm. Salant and A. E. Livingston (by invitation). (Read by title.)

"Colorimetric Method for the Estimation of Free Formaldehyde," by R. J. Collins (by invitation), and P. J. Hanzlik.

"Salicyluric Acid," by P. J. Hanzlik.

"The Anesthetic Tension of Ether Vapor in Man," by W. M. Boothby (by invitation).

Officers for 1916: During the first executive session on Monday afternoon, December 27, the following officers for the year 1916 were elected:

President: Reid Hunt.

Secretary: J. Auer.

Treasurer: Wm. de B. MacNider.

Additional Members of the Council: A. D. Hirschfelder, George B. Roth.

Membership Committee: C. W. Edmunds (term expires 1918), Torald Sollmann (term expires 1916).

New Members.—During the second executive session held Tuesday morning, December 28, the following candidates for membership, who have been passed by the membership committee and the council were elected by the society.

Russel J. Collins, Western Reserve University Medical School.

J. F. Corbet, University of Minnesota.

O. Folin, Harvard Medical School.

R. J. Hoskins, Northwestern University Medical School.

Paul D. Lamson, Johns Hopkins Medical School.

Robert L. Levy, Johns Hopkins Medical School.

C. C. Lieb, Columbia University.

E. K. Marshall, Jr., Johns Hopkins Medical School.

David I. Macht, Johns Hopkins Medical School.

Louise Pearce, Rockefeller Institute.

Richard Weil, Cornell University Medical School.

At the close of this session a motion was made, seconded and unanimously carried, that a vote of thanks be extended to the Harvard authorities and to the local committee for their efforts which contributed largely to the success of the meetings.

Dinners.—Two informal subscription dinners were given on the evenings of December 27 and 28 at headquarters, the Hotel Lenox. At the first dinner the chairman of the federation, Dr. Sollmann, gave a brief review of the history of the federation and pointed out some possible future developments. The chairman then called upon Drs. W. B. Cannon and Walter Jones, who responded by pithy speeches.

Meeting Place for 1916.—The Pharmacological Society, together with the other members of the federation, will meet in New York City in 1916 with the American Association for the Advancement of Science.

J. AUER,
Secretary

ROCKEFELLER INSTITUTE,
January 6, 1916

THE AMERICAN PHYSIOLOGICAL SOCIETY

The twenty-eighth annual meeting of the American Physiological Society was held in conjunction with the constituent societies of the Federation of American Societies for Experimental Biology in the physiological laboratory of the Harvard Medical School, Boston, Mass., December 26 to 29, 1915. There was an unusually large attendance of the members. No less than 63 scientific papers, 23 demonstrations and 4 papers by titles were presented on the program.

The initial joint meeting with the biochemists, pharmacologists and pathologists Monday morning, the twenty-seventh, was opened by a symposium on "Food Accessories" in which the discussion was led by Drs. L. B. Mendel, E. V. MacCollum and Carl Voegtlin. The high scientific excellence of this first joint meeting is indicated by the list of names of participants, namely, W. H. Howell, Jacques Loeb, W. B. Cannon, Otto Folin, A. L. Meyer, E. K. Marshall, Leo Loeb, J. B. Murphy and Harvey Cushing.

The complete list of papers and demonstrations is as follows:

Symposium.—"Food Accessories." Discussion opened by T. B. Osborne and L. B. Mendel, Casimir Funk, E. V. McCollum, Carl Voegtlin.

"The Formation and Structure of the Fibrin Gel," by W. H. Howell.

"Experiments on the Mechanism of Osmosis," by Jacques Loeb.

"Further Observations on Over-activity of the Cervical Sympathetic," by W. B. Cannon and R. Fitz (by invitation).

"Some New Observations on the Uric Acid Content of the Blood," by Otto Folin and R. D. Bell (by invitation) with the assistance of G. Le B. Foster.

"On Continuous Insufflation Through the Humerus in Fowl," by A. L. Meyer (by invitation) and S. J. Meltzer.

"The Influence of the Adrenals on the Kidney," by E. K. Marshall and D. M. Davis (by invitation).

"Heredity and Internal Secretion in the Origin of Cancer in Mice," by Leo Loeb.

"The Effect of X-rays on Cancer Immunity," by James B. Murphy.

"The Presence of Posterior Lobe Secretion in the Cerebro-spinal Fluid," by Harvey Cushing and Gilbert Horrax (by invitation).

"The Influence of Gastrectomy on Subsequent Pancreatectomy in Dogs," by J. R. Murlin and J. E. Sweet.

"The Distribution of Suprarenin-yielding Tissue in Different Animals," by M. E. Fulk (by invitation) and J. J. R. Macleod.

"The Action of Minimal Doses of Adrenalin," by Walter J. Meek.

"The Effects of Suprarenal Feeding on the White Rat," by R. G. Hoskins and Augusta D. Hoskins (by invitation).

"Adrenalin Content of the Blood in Conditions of Low Blood Pressure and 'Shock,'" by E. A. Bedford (by invitation), and H. C. Jackson.

"Rhythmical Changes in the Resistance of Dividing Sea-urchin Eggs to Hypotonic Sea-water," by Ralph S. Lillie.

"Mass-action in the Activating Effect of Butyric Acid on Unfertilized Starfish Eggs," by Ralph S. Lillie.

"The Permeability of Animal and Plant Cells," by W. J. V. Osterhout.

"On the Rôle Played by Electrolytes in Determining the Permeability of Protoplasm," by G. H. A. Clowes.

"Three Types of Muscular Response in Sea-anemones," by G. H. Parker.

"The Relation of Certain Muscles to Oxygen," by F. S. Lee, A. E. Guenther and H. E. Meleney (by invitation).

"Influences Affecting Voluntary Muscular Work—Especially Age and Tobacco," by Warren P. Lombard.

"The Function of the Kidney When Deprived of its Nerves," by Wm. C. Quinby.

"Electrocardiographic Studies in Normal Infants," by Edward B. Krumbhaar.

"The Time Relations of Auricular Systole," by C. J. Wiggers.

"The Movements of the Mitral Valves in Relation to Auricular and Ventricular Systoles," by A. L. Dean (by invitation).

"Further Researches on the Relation of the Chronotropic Action of the Vagus to the Nodal Tissues," by H. Steenbock, J. A. E. Eyster and Walter J. Meek.

"The Tension of Carbon Dioxide and Oxygen in Venous Blood at Rest and at Work," by W. M. Boothby (by invitation) and I. Sandiford (by invitation).

"The Chief Physical Mechanisms Concerned in Clinical Methods of Measuring Blood-pressure," by Clyde Brooks and A. B. Luckhart.

"Haemodynamical Studies," by R. Burton-Opitz.

"The Mechanism of the Arterial Compression Sounds of Korotkoff," by Joseph Erlanger.

"The Responses of the Vaso-motor Mechanism to Different Rates of Stimulation," by Charles M. Gruber.

"Vaso-motor Summations," by E. G. Martin and P. G. Stiles.

"Blood Changes Following Hæmorrhage and Infusion," by Theodore Hough and J. A. Waddell (by invitation).

"Experimental and Clinical Studies on Mental Defectives. III. The Relation of Systolic and Diastolic Blood Pressures and Their Power of Adjustment to Body Position," by A. W. Peters and C. D. Blackburn (by invitation).

"Prolonged Uniform Intravenous Injections," (lantern), by R. T. Woodyatt.

"The Deglutition Center in the Medulla Oblongata," by F. R. Miller.

"Demonstration of the Agglutination of Bacteria in Vivo," by Carroll G. Bull (by invitation).

"A Method of Obtaining Suspensions of Living Somatic Cells of the Higher Animals," by Peyton Rous and F. S. Jones (by invitation).

"Analogous Antagonistic Effects Exerted by Electrolysis and Anesthetics on Physical Systems and Living Cells," by G. H. A. Clowes.

"The Action Current of Glands," by W. B. Cannon and McKeen Cattell (by invitation).

"A New Type of String Galvanometer and Accessory Apparatus," by Horatio B. Williams.

"Apparatus for the Investigation of Cardiodynamics," by Robert Gesell.

"A Circulation Model," by A. L. Prince (by invitation).

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"A Motor-driven Airblast Interrupter for Artificial Respiration," by W. B. Cannon.

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"A Simplified Procedure for the Determination of Carbon Dioxide Tension in the Alveolar Air," by W. McK. Marriott.

"A Quantitative Pump for Prolonged Intravenous Injections," by R. T. Woodyatt.

"Some New Apparatus," by D. E. Jackson.

"Apparatus for Recording Graphically the Movements of Melanophores," by Raymond Spaeth (by invitation).

"Further Studies on the Elective Localization of Streptococci," by Edward C. Rosenow.

"On Nephelometric Methods; Reagents for the Estimation of Proteins, Nucleic Acids, Purin Bases, Uric Acid, Phosphorus and Ammonia (Graves' Reagent)," by P. A. Kober.

"The Perfected 'Shadow Pupillometer,'" by George W. Fitz.

"A Simple Rheostat for Laboratory Use," by E. G. Martin.

"A Motor Driven Circuit Breaker," by E. G. Martin.

"The Mode of Action of Ultra-violet Radiation in Destroying Hormones, Proenzymes, Enzymes and Living Cells," by W. E. Burge.

"Initial Length, Initial Tension and Tone of Auricular Muscle in Relation to Myo- and Cardiodynamics," by Robert Gesell.

"Is the Contraction of Smooth Muscle Accompanied by Heat-production?" (second communication), by C. D. Snyder.

"The Experiment of Valsalva," by Percy M. Dawson and P. C. Hodges (by invitation).

"Comparative Studies in the Physiology of the Gastric Hunger Contractions in the Amphibia and the Reptilia," by T. L. Patterson (by invitation).

"Localization by Faradic Stimulation in the Floor of the Fourth Ventricle," by F. R. Miller.

"Direct Evidence of Duodenal Regurgitation and its Influence upon the Chemistry and Function of the Normal Human Stomach," by W. H. Spencer (by invitation), G. P. Meyer (by invitation), and P. B. Hawk.

"The Diuretic Action of Tissue Extracts," by Frank P. Knowlton.

"The Appearance of Sugar in the Digestive Secretions in Phloridzin Glycosuria," by Roy G. Pearce.

"The Rapidity with which Alcohol and Some Sugars are Available as Nutriment," by H. L. Higgins.

"Some Results of Studies on Electrical Changes in Glands," by W. B. Cannon and McKeen Cattell (by invitation).

"The Action of the Depressor Nerve on the Pupil," by J. Auer.

"Evidence Showing the Metaphore to be a Disguised Type of Smooth Muscle," by Raymond Spaeth (by invitation).

"The Voluntary Innervation of Skeletal Muscle," by E. G. Martin and R. W. Lovett (by invitation).

"Comparison of the Chemical Changes in the

Central Nervous System in Pellagra and in Animals on an Exclusive Vegetable Diet," by M. L. Koch (by invitation), and Carl Voegtlin.

"A Study of a Lecithin-glucose Preparation," by Ernest L. Scott.

"Effect of Excluding Pancreatic Secretion from the Intestine on the Absorption of Nitrogen and Fat," by Joseph H. Pratt.

"The Fat of the Blood in Relation to Heat-production, Narcosis and Muscular Work," by J. R. Murlin and J. A. Riche (by invitation).

"The Fat and Lipase Content in the Blood in Relation to Fat Feeding and to Fasting," by C. W. Greene and W. S. Summers (by invitation).

"Some Practical Applications of Feeding Experiments with Albino Rats," by Thomas B. Osborne and Lafayette B. Mendel.

"The Influence of Chemical Substances on Immune Reactions, with Special Reference to Oxidation," by Aaron Arkin.

"The Effect of Thyro-parathyroidectomy on the Blood Coagulation Time in the Dog," by Sutherland Simpson and A. T. Rasmussen (by invitation).

"Detection with the String Galvanometer of Afferent Impulses in the Brain-stem and Their Abolition with Ether Anesthesia," by A. Forbes and R. H. Miller (by invitation).

"A Smooth-muscle Nerve Preparation," by C. D. Snyder.

"Cinematograph and Lantern Demonstration of Some Effects of Lesions of the Nervous System," by F. H. Pike.

"On the Secretory Discharge of the Pituitary Body Produced by Stimulation of the Superior Cervical Ganglion," by V. N. Shamoff (by invitation).

"Concerning the Action of Various Pituitary Extracts on the Isolated Intestinal Loop," by V. N. Shamoff (by invitation).

"The Influence of Certain Cereal Foods on the Gastric Secretion," by C. C. Fowler (by invitation), M. E. Rehfuss (by invitation), and P. B. Hawk.

"Changes in the Composition of the Body of Fasting Lobsters," by Sergius Morgulis.

"A Note on the Contractility of the Musculature of Auriculo-ventricular Valves," by Joseph Erlanger.

"The Psychic Secretion of Gastric Juice," by R. J. Miller (by invitation), M. E. Rehfuss (by invitation), and P. B. Hawk.

Notwithstanding the limited time of fifteen minutes allowed for each paper and its discussion, there was sustained interest in the meetings throughout the six sessions. This was contributed to in no small part by the vigorous discussions. The secretary feels that this was one of the most fruitful features characterizing the meetings.

Of the business transactions the most important to the progress of physiological science was the vote to collaborate with the British Physiological Society in the publication of "Physiological Abstracts." It was the feeling that the society owed it to the younger physiologists and to the ever-growing fields of practical research in the subject to make the results of physiological investigation available in the English language.

The Council reported an unusually prosperous year in the publication of the *American Journal of Physiology*, and it was recommended and the society voted to take steps to increase the circulation of the *Journal*, especially among the membership. The hope was expressed that an increased circulation would make possible both a reduction in the cost per volume of the *Journal* to members and an increase in the size of the volumes.

An unusual number of new members were elected as follows: Walter R. Bloor and Walter M. Boothby, Harvard Medical School; Thornton M. Carpenter, Nutrition Laboratory of the Carnegie Institution; George H. Baitsell, A. L. Prince and Reynold A. Spaeth, Yale University; T. S. Githers, Rockefeller Institute; Edward C. Day, Syracuse University; C. K. Drinker, Katherine R. Drinker, E. K. Marshall, George Peirce and D. W. Wilson, Johns Hopkins University; N. R. Blatherwick, Department of Agriculture, Washington; Herbert S. Gasser, University of Wisconsin; Addison Gulick, University of Missouri; C. W. Hooper, Hooper Foundation, San Francisco; Benjamin Kramer, University of Iowa; Walter L. Mendenhall, Dartmouth College; Maud L. Menton, Barnard Skin and Cancer Hospital, St. Louis; S. W. Ranson, Northwestern University.

The officers elected for the ensuing year are: *President*, W. B. Cannon; *Secretary*, C. W. Greene; *Treasurer*, Joseph Erlanger; *Member of the Council for 1916–1919*, W. J. Meek.

A hopeful feature of the meeting was the fact that the attendance persisted through the entire series of six sessions, a fact that was contributed to in no small measure by the active cooperation and boundless hospitality of the "Local Committee."

Chas. W. Greene,
Secretary

University of Missouri,
January, 1916

SCIENCE

FRIDAY, FEBRUARY 25, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE INTERRELATIONS OF PURE AND APPLIED CHEMISTRY[1]

WITHIN the past fifty years there has been a revolution in civilized industries more far-reaching in its effects than the rise or fall of dynasties or the arbitrament of war. It is a quiet, peaceful revolution, so unobtrusive that even its active agents have rarely been aware of its significance. Even the astounding efficiency of armies in the present European war is but a minor item in the forward movement.

This revolution, which is still going on, and may continue indefinitely, is both simple and complex. It is merely the gradual substitution of scientific accuracy for empiricism, of quantitative and rational methods for rule of thumb. It means better service, better wares, intelligent agriculture, improved sanitation, the suppression of epidemics, and the prevention of waste. Through its agency the luxuries of a century ago have become almost necessities; travel has been made easier and cheaper; commerce is broadened; and all the nations of the earth are now brought together in a community of interests which is only interrupted temporarily by war. Even the horrors of war are somewhat mitigated by the beneficent activities of the Red Cross service, which owes much of its effectiveness to the discoveries of science; an effectiveness which would have been impossible in the days of our grandfathers. With the aid of modern inventions the powers not at war are now able to relieve much of the suffering due to war. Steam and the telegraph have made charity more prompt and

[1] Address before Section VII. of the Pan-American Scientific Congress, January 3, 1916.

effective; while antiseptics and anesthetics, the products of chemical research, have checked the spread of disease and relieved pain.

Throughout this revolution chemistry has played and is still playing an important part. It not only touches every branch of industry, but it also reaches out into other fields of knowledge and aids their development. The geologist demands chemical data; physiology is in great part chemical; astronomy makes use of chemical discoveries whenever it analyzes the spectrum of a nebula or star.

In these preliminary remarks, I have suggested only the applications of science to the "betterment of man's estate"; but suppose there had been no science to apply. Suppose that no inquisitive mortals had ever cared to study apparently useless things, or to ponder over those obscure relations which foreshadow the discovery of natural laws. Civilization would have advanced, doubtless; but so slowly that centuries or even millenniums of progress could hardly have placed us on the level of to-day. If our predecessors had only considered mere utility, the great inventions of chemistry and electricity would never have been made. These inventions were the outgrowth of investigations that were conducted without thought of practical uses, but were searchings after truth alone.

History is full of paradoxes; and so I must seem to contradict myself when I say that the beginnings of science, the germs from which it grew, were certainly utilitarian. Discoveries were made by accident; of metals, of medicines, of dyes, and, probably earlier still, of fire. Facts, useful to mankind, were slowly collected, and in time, by the crudest of mental processes, were roughly classified. Similar things were grouped together, simple relations were observed; and these were the raw material with which science, as we understand it, began. Arts were highly developed before true science became possible. To trace their advance from savagery to civilization is one of the functions of anthropology.

The science of chemistry deals primarily with transformations of matter. Perhaps the first of these to attract attention was the change of wood to charcoal, but such transformations were doubtless taken as a matter of course, and gave rise to no serious reasoning. With the ancient Greeks, however, and perhaps earlier in Egypt, India and Crete, the accumulations of empirical knowledge led to speculations, and philosophers began to consider the absolute nature of matter. The Greek speculations are well known, but they were speculations only and bore no useful fruit. It was only after systematic experimentation had supplied a real basis for reasoning that chemical theory became possible. The Greeks were acute philosophers, but experimental work was the province of artisans, and so fact and theory rarely came together.

Slowly, however, a body of chemical doctrines developed, largely esoteric, and known only to the initiated, who had very practical aims in view. They sought to discover medicines and poisons, to transmute base metals into gold, to find a universal solvent and the elixir of life. Through their efforts many useful compounds were brought to light, but the problems they sought to solve were unsolvable. Their discoveries were the by-products of their researches, not the main object of their desires. Their speculations led to experiments, and in this union of theory, even false theory, with practise, modern chemistry began. By slow degrees empiricism developed into scientific method, and as the field of knowledge was enlarged, valid generalizations, true stimulators of rational research, were framed.

The union of theory and practise, that is the keystone of modern chemistry. Theory coordinates and arranges; practise discovers, and each one helps the other. The concrete facts of science, taken only as facts, form a disorderly and unmanageable mob; good theory converts them into a disciplined army. A thousand isolated facts are not easily remembered, theory brings them all under one general expression, and the difficulty disappears. Empirical knowledge is an aggregation of facts; theory combines them into that systematic organization which we call science. Chaos gives way to order. Theory, moreover, not mere speculation, guides research into profitable paths and makes practise more surely fruitful. The self-styled "practical man," who affects to despise theory, is apt to go astray, and to waste his time in haphazard experimenting. The Patent Office is the graveyard of many such fruitless efforts.

Let me illustrate my meaning by a concrete example: In theorizing upon the nature of matter the Greek philosophers developed an atomic speculation which was the subject of controversy, of arguments pro and con, for more than twenty centuries. It was speculation only, and it led to no definite results, for it rested upon no adequate basis of experiment.

A little more than a century ago John Dalton proposed an atomic theory which had for its purpose the correlation and explanation of certain established relations. In this respect it differed from mere speculation about what might or ought to be; it was something more than an affair of words and syllogisms, and, furthermore, it assumed quantitative form. In Dalton's hands the theory led to the discovery of those fundamental constants of matter which we call the atomic weights, with which the physical properties of the chemical elements are intimately connected. It was a fruitful theory, capable of growth, and for a hundred years it has been the chief guide of chemical research.

In the first place the atomic theory gave us, or at least made possible, our system of chemical formulæ, by which the composition of compound substances can be clearly and easily expressed. A vast number of individual data were thus brought into order, and became manageable. With these formulæ equations could be constructed and chemical arithmetic was born. Nearly all chemical calculations, especially the calculation of analyses, rest upon the constants which Dalton discovered. As a labor-saving device the atomic theory has been of enormous value. Chemical operations are also made more exact and economical by the calculations which theory has rendered possible, and wastage is avoided.

But this is not all. From the main stem of the theory subordinate theories have branched, and the theory of valency is one of them. Chemical knowledge became still more systematic and orderly, and chemists were guided into profitable lines of research. For instance, the benzene ring of Kekulé, a conception which had at first only scientific interest, led to consequences of the highest practical significance. The whole development of coal-tar chemistry, for over fifty years, with its discoveries of dyestuffs, medicines and explosives, has been systematically guided by Kekulé's generalization. Theory and practise have worked together and to mutual advantage. Pure science and applied science have both been benefited.

Between pure chemistry and applied chemistry there is no sharp line of demarcation; both are phases of one science which can not be subdivided. The difference between them is one of point of view, of purpose, or of temperament on the part of the investigator. One chemist seeks for

truth, regardless of its possible utility; another strives to apply the truth to the material welfare of mankind. The truth comes first, however; its applications only follow. The great edifice of applied science rests upon foundations of pure research. The work of Gilbert, of Galvani, of Volta, of Faraday, preceded the electrical advances of to-day. The seemingly useless discoveries of one generation have made modern inventions possible. In every department of science this principle holds true, and in none more than in chemistry. A single fact, insignificant by itself, may be the final link in an important chain of evidence.

The uses of a discovery can not be foreseen. Aniline was useless for many years after its discovery, but its importance is much in evidence to-day. Bromine and iodine were chemical curiosities at first, but they had much to do with the development of photography; an art which came into existence years after the two elements were first made known. So-called rare metals, unimportant only thirty years ago, have now found applications and are commercially valuable. Tungsten and vanadium are used in hardening steel, and tungsten also forms the filaments of incandescent lights. Thorium is utilized in the Welsbach mantle, chromium and titanium have found new uses; and the list might be indefinitely extended. Discovery came first, utilization was always much later. Modern bacteriology grew out of a controversy between two chemists, Pasteur and Liebig, who held opposing views as to the nature of fermentation. They fought over principles, and the practical consequences of the final decision could hardly have been anticipated.

Every argument has two sides. If applied chemistry owes much to pure chemistry, it has given much in return. It has stimulated research and suggested new problems. An honest investigation in the field of applied science is likely to yield some data of no immediate use in industry, but nevertheless of real scientific interest. Such data are often more than isolated facts, for they may fill gaps in our knowledge, or serve as evidence in the establishment of some principle. The search for useful derivatives of coal-tar, for example, has led to the discovery of thousands of compounds which, although commercially unavailable, have yet helped to build up the colossal structure of organic chemistry. Theory has aided practise, and practise has done much to strengthen theory. Neither side can claim absolute supremacy.

In all that I have said so far there is nothing new, at least to men of scientific training. We all know the outlines of chemical history, and can agree in a general way as to fundamental principles. But knowing and realizing are two different things. We become so accustomed to objects immediately about us that we often fail to realize their presence unless they are constantly used. It is the same with principles and ideas. The work we are actually doing absorbs our thoughts, and we forget or unconsciously ignore the equal, perhaps greater importance of other things. We know but do not realize. The most obvious truths are those which oftenest need to be recalled. They are so obvious that they no longer attract attention. On occasions like this it is permissible to emphasize them, and truisms become respectable.

I speak now to experts; but what of the layman, the employer of labor, the consumer of scientific results? How far can he be made to realize that his applications of science rest, not upon empirical experimentation, but upon a long line of seemingly abstract researches, guided by theories which to him appear to be visionary?

To this question no general answer can

be given, and for obvious reasons. Some manufacturers are ignorant and stupid, the ultra-conservatives; others are intelligent, progressive, wide-awake. Great advances, however, have been made, and the good work still continues. The older men among us can remember the time when American mills and factories rarely employed a chemist, except when difficulties were encountered which could only be solved by analysis. Even then the cost of the work was paid most grudgingly as if it were an extravagance which should have been avoided. Now it is usual for manufacturing corporations to maintain laboratories, in which chemists, too often underpaid, are regularly employed. Some companies, the General Electric Company, for example, spend large sums of money on research, but others are more niggardly. Here we have much to learn from Germany. Her great advances in chemical industries have been made possible by the employment of trained investigators, whose duty it is to discover new products of value and to improve processes. Men who had shown ability in the solution of unsolved problems were chosen for this work, and not mere analysts only. In Germany, more than in any other country, has the commercial value of scientific intelligence been realized. The routine man has his place, but the thinker outranks him. When American employers are willing to spend as much time and money on research as they now spend on law, their economic conditions will be much improved. The chemist who solves an important problem, or who shows how to avoid waste, might well be paid as much as the lawyer, who, after all, may only lose his case. Although we are improving, we still have far to go.

A congress of this kind is of slight importance unless it can bring forth suggestions which shall help in the future advancement of science. It is, of course, pleasant to meet together, to compare notes and to form new friendships, but something more serious and permanent is demanded. What does science need, and what are its weak points? These are questions worth considering.

So far, with few exceptions, science has advanced through the efforts of individuals, and not by any definite system. The result is, especially in chemistry, an ill-balanced body of knowledge, overdeveloped in some directions, underdeveloped in others. The individual studies the subject which interests him and has attracted his attention, and too often fails to think of chemistry as a whole. Our knowledge is full of gaps, and these frequently occur where one would least expect to find them. We know many physical constants, for example, but for no single substance have all the desirable data been determined. This is a condition which should be remedied—but how?

The essential thing, it seems to me, is that there should be greater cooperation among investigators, and a subordination of personal interests to the general welfare. There are individual geniuses, of course, whose imagination reaches out into the unknown, and brings back wonderful discoveries; but such men must work alone and never in harness. They are the glorious few; I speak for the laborious many. Nor do I suggest any check to individual enterprise, only that it should be supplemented and helped by some intelligent system.

In every department of science there are problems too large for any single worker to handle, and here cooperation is possible. In this direction astronomers have set us an example, and observatories now combine their resources in mapping the starry heavens. Each observatory takes a definite zone, and the work goes on systematically. Such cooperation is practicable, and it leads to

permanent results. A definite field of work is definitely divided, and then cultivated under a preconcerted plan.

In chemistry, however, institutions equivalent to astronomical observatories can hardly be said to exist. Therefore, it is desirable that they should be created. Laboratories for systematic research are needed, in which bodies of trained men can work together for the common welfare. The work most needed to be done is not showy, but laborious; it will bring little fame to the individual, whose personal interests, however, need not be wholly disregarded.

To make my meaning clear I may cite one line of investigation which might be taken up, the importance of which I have discussed on several previous occasions. The great, fundamental problem which I have in mind is this: what relations connect the physical properties of compounds with those of their component elements? How can we calculate the one from the other?

The first thing to do, evidently, is to determine with accuracy the physical constants of the elements themselves; for just here our present knowledge is wretchedly incomplete. Take iron, or gold, or copper, for instance; how much do we know of their fundamental properties? A fraction only, a small fraction of what should be known. Here, then, is one line of work for an organized laboratory to do; one which would lay the foundations for great generalizations. Each constant should be measured throughout the entire range of attainable temperature; excepting only those which hold for one temperature alone. To accomplish all this new methods would have to be devised, and new instruments invented; and this would be of service to industrial enterprises as well as to science. The great revolution of which I spoke at first would be still farther advanced, precision would replace present uncertainty; all chemistry and all physics, the Siamese twins of science, would reap unforeseeable advantages.

A modern dreadnought costs, with its equipment, fifteen millions of dollars. It may be sunk by a torpedo in the first week of its career, or it may last twenty-five years, never meeting an enemy, and then be discarded as obsolete. The battleship is necessary, no doubt, at least as society is now organized; but it is unproductive, an instrument of destruction, and, therefore, perhaps unavoidably, a waste.

Fifteen millions of dollars! For one fifth of that sum a laboratory for research could be built, equipped and permanently endowed, which would benefit mankind for centuries to come. Surely some of the wealth which chemistry has created might well be devoted to such an enterprise as I am advocating now. Libraries, observatories and museums have all been enriched by private beneficence, but here is something of no less merit for which no provision has been made. Let us hope that the forward step may first be taken somewhere within the Western Hemisphere.

Between pure and applied science, or, rather, between the scientific investigator and the so-called "practical" man, there is often, but not always, an unfortunate difference. The worker in pure science publishes his discoveries to the world, regardless of commercial values. The manufacturer, on the other hand, who pays or thinks he pays for scientific investigations, is apt to keep his results secret, in order that he may turn them to personal profit. This policy of secrecy, too often followed, is bad for science and for industry. Science is deprived of useful data, which might add greatly to its advancement. Manufacturers waste their time and money in duplications of research, or, frequently, in rediscovering that which is already well

known. I have myself seen a supposedly "secret" process which had been in print for many years and was doubtless known to all competitors. Temporary secrecy, pending applications for patents, is of course not objectionable, but permanent secrecy is wrong. The man who uses science in developing his industry owes something to science in return. In the long run, moreover, publicity regarding scientific investigations is profitable. With a liberal policy, each manufacturer would give out his own small contributions to science, and receive the results obtained by all others in return. The practise of secrecy, to use the common phrase, is penny wise and pound foolish.

I plead, therefore, not only for cooperation in pure research, but also for greater cooperation, for more reciprocity between investigation and industry. The application of science to human welfare is glorious; its selfish uses are at least not praiseworthy. The devotee of pure science and the technologist should seek to understand each other, and to realize that the conduct of research involves mutual responsibilities. We may not attain to our ideals, but we can surely move towards them.

To-day the thoughts of the civilized world are turned towards war, and all men are longing for the peace which must come, sooner or later. As one of our earliest poets has said:

> War ends in peace, and morning light
> Mounts upon midnight's wing.

That is true of material warfare, but we are engaged in a conflict which, fortunately, can never end. It is the war of intelligence against the inertia of ignorance, and it keeps intelligence alive. Ignorance will always exist; the unknown will always be vaster than our knowledge, but we may hope for many future victories, and fear no ruinous defeats. So long as science lives it must move forward, driven by a splendid discontent with our deficiencies. May we never be satisfied, and forever advance, safe in the conviction that every conquest of ours over ignorance means the greater welfare of mankind.

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THEODOR BOVERI[1]

WITHIN a single year after Weismann's death our science has suffered another severe blow in the loss of Theodor Boveri, who died in Wuerzburg on October 15 at the age of fifty-three years. Pioneer and leader in the fields of cytology and experimental zoology, his loss will be felt keenly in this country where he had so many friends and pupils and where his field of research has been so popular during the past two decades. Boveri's personal life was very simple, always devoted to his work, his family and the pleasure coming from a deep love for art and nature. A native of Bavaria, he studied first philosophy and later zoology in Munich. His doctor's thesis on the structure of the nerve fibers in vertebrates treated a subject to which he did not later return. For, encouraged by his teacher, Richard Hertwig, soon after receiving his degree he entered the field of cytological research. Here, following the example of his teacher, he combined practically from the beginning the morphological and experimental methods.

His very first work in this line proved to be a great success, securing to him the *venia legendi* as privat dozent in the University of Munich. A few years later, when only thirty years of age, he was called to Wuerzburg, to succeed Semper in the chair of zoology and comparative anatomy. Here he remained during the rest of his life with the exception of frequent trips to the zoological stations of southern Europe, especially Naples, where he was a regular guest. He also made a short visit to the United States. His reputation as

[1] Paper read before the Biological Club, Yale University, December 3, 1915. I am greatly indebted to Professor Wesley R. Coe for kindly revising the manuscript.

an investigator soon attracted scores of students to the quiet laboratory in Wuerzburg, many of them coming from this country. One of the first, Miss O'Grady, of Vassar College, became his faithful wife, the mother of his daughter and an efficient assistant in all his later scientific work.

It is hardly necessary to add that with his growing fame came numerous honors conferred on him by his university, where he held the highest office as rector magnificus in 1909, by his government and by learned societies. Among the learned societies which conferred on him their membership is the American National Academy of Sciences.

When Weismann resigned his professorship in Freiburg Boveri was called to succeed him, but declined. Later the directorship of the new research laboratory of the Kaiser-Wilhelm-Gesellschaft in Berlin was offered to him. He first accepted, worked out the whole organization and brought together the staff; but suddenly he declined again. Possibly he already felt that his health was no longer vigorous enough for such a change. When I saw him for the last time, two years ago, in Naples, he gave me the impression of a strong and healthy man, but within a short time a disease of the gall-bladder forced him to interrupt his teaching for a year. An operation performed in the first days of October could not save his life.

When Boveri entered the field of biological research in the middle of the eighties the science of cytology was just outgrowing its childhood. Only ten years previously the fundaments had been laid. After certain incidental observations, especially by A. Schneider and Auerbach, Otto Buetschli collected his results on the division of the cell, the maturation and fertilization of the egg and the conjugation of Infusoria in his classic work of 1876. From that time dates the knowledge of the karyokinetic division of the cell with all its consequences. At about the same time appeared O. Hertwig's classic work on the fertilization of the sea-urchin egg, making it clear for the first time that fertilization is the union of egg- and sperm-nucleus. Then followed one fundamental discovery after another. Strasburger soon applied the new facts to the cells of plants. Flemming (1882) worked out the details of the mitotic figure, introduced the term "chromatin" and discovered the longitudinal splitting of the chromosomes. Roux (1883) realized the theoretical importance of the new discoveries and pointed out the meaning of the mitotic division of the cell, anticipating practically all of the views of to-day. In 1884 Heuser for plants and Van Beneden for animals were able to prove that the separated halves of the chromosomes are distributed to the daughter cells. (The word chromosome was first introduced in 1888 by Waldeyer.) At the same time Naegeli (1884) developed his ingenious theory of the idioplasm, and soon Strasburger, Koelliker, O. Hertwig, Weismann pointed to the chromosomes as the seat of the material basis of heredity. Only one important step was still lacking, the full understanding of the process of fertilization. Mark (1881) came very near to making this discovery, but it was Van Beneden (1884) who proved that in fertilization the same number of paternal and maternal chromosomes are handed over to the cleavage cells. These discoveries were made on the eggs of *Ascaris,* studied previously by A. Schneider and Nusbaum, and which have since become one of the classic objects of cytology. One after the other followed in those days the discoveries, which elucidated the whole process; the meaning of the polar bodies (Buetschli, O. Hertwig, Giard, Mark); the parallelism between ovogenesis and spermatogenesis (Van Beneden et Julin); the theory of the reduction division (Weismann); the behavior of the polar bodies in parthenogenesis (Blochmann, Weismann and Tshikawa); the continuity of the germ-plasm (Nusbaum, Weismann); the individuality of the chromosomes (Rabl); and finally, in 1887, the foundation of experimental cytology by O. and R. Hertwig. This was the year when Boveri's first "Zellstudien" appeared.

Under the influence of Van Beneden's classic book, Boveri began by studying the sex cells of *Ascaris.* In his Zellstudien, I., 1887, he

takes up the subject of the formation of the polar bodies. In harmony with Buetschli's discovery Schneider and Nusbaum had described the formation of the polar bodies in *Ascaris* as a regular mitosis, whereas Van Beneden and Carnoy insisted that it was a different process. Boveri proved that the former view is correct and was able to explain many discrepancies of these authors by discovering that there are two different varieties of *Ascaris* in regard to their number of chromosomes, called to-day univalens and bivalens. It is of interest to note that he expresses here the view that the recently discovered formation of a single polar body in parthenogenetic eggs may be explained by the assumption of a fertilization of the egg nucleus through the second polar nucleus. In 1888 appeared Boveri's Zellstudien II., dealing with the fertilization and division of the *Ascaris* egg. Here we find—besides many morphological details—his formulation of the theory of the individuality of the chromosomes, founded, as he freely recognized, by Rabl, and since one of the fundamental principles of cytological research. And he furnished important proofs by comparing the prophases of the division with the last telophases, and further by showing, that in cases of abnormal distribution of the chromosomes as many of them came out of the resting nucleus as had entered it. He was further especially interested in the mechanics of cell-division. He attributed a great importance to the special plasm surrounding the centrosome, the archoplasm (a theory abandoned later by him), and pointed to the importance of the continuity of the central bodies called by him centrosomes, already discovered by Van Beneden. And here we find developed also his idea, that the main importance of fertilization is the introduction of a centrosome into the egg. Starting from some abnormal cases, where a division of the cell is possible without a nucleus, he reached the conclusion that the centrosome is the dividing-organ of the cell. It is of importance to note that he emphasized even in this early paper (pp. 10–11) the necessity of experimental analysis of the phenomena of fertilization and heredity, recently inaugurated by the brothers O. and R. Hertwig.

To all these problems studied in *Ascaris* he furnishes a supplement in Zellstudien III., 1890, by applying the same studies on many marine invertebrates during a sojourn at Naples. For each of the objects investigated he could prove Van Beneden's law concerning the chromosomes in fertilization to be correct. Further he shows that in all these animals the reduced number of chromosomes is found even at the beginning of the maturation divisions in both sexes. The real reduction, therefore, must occur as early as in the oogonia and spermatogonia. It may be added here that during these years the complete parallelism of the cycle of male and female sex cells was definitely proven by the work of Van Beneden et Julin, Boveri, Platner and O. Hertwig, and that at the same time the problem of the reduction division was solved through Henking's idea of a conjugation of the chromosomes (the term introduced by Boveri), proved to be true by Rueckert (1891). As the final word of all his studies during these years may be regarded his article "Befruchtung" in Merkel und Bonnet's Jahresbericht, 1891, where he reviews the whole field in his keen and masterly way. It is of special importance that here were published the first figures of the process of diminution of the chromosomes, some years previously discovered by him in the cleavage cells of *Ascaris* and fully understood in its importance for the doctrine of the Keimplasma.

It has been stated already how keenly Boveri felt the necessity of applying experimental methods to the study of cytology. His first papers in this direction were published in 1888 and 1889. The latter especially gave a great impetus to our science, his famous report, "Ueber einen geschlechtlich erzeugten Organismus ohne muetterliche Eigenschaften."

The brothers Hertwig had succeeded in rearing fragmented eggs of Echinoderms up to the gastrula stage and had been able to fertilize enucleated fragments of sea-urchin eggs. Boveri conceived the very ingenious idea of using this method, to determine whether or

not the hereditary qualities are transmitted in the nucleus. He therefore fertilized enucleated egg-fragments of *Sphærechinus* with the sperm of *Echinus* and raised the resulting larvæ to the pluteus stage. He believed he was able to prove that these larvæ exhibited only paternal characters. It is well known that the validity of this conclusion was attacked by Morgan and by Seeliger. It was not until 1896 that Boveri published, in *Roux's Archiv*, the full account of this work and answered the objections of his critics. To-day we know from the work of many observers that the question is not a simple one. But in this paper we find incidentally another discovery, taken up by Boveri much later; namely, the dependence of the size of the larval nuclei upon the number of their chromosomes.

It is well known that during this first decade of Boveri's work our science was revolutionized. In the years 1884–88, Wilhelm Roux had laid the foundations of the science of Entwicklungsmechanik and the brothers Hertwig had started their experimental work in cytology and hybridization. Soon Driesch (1891) imbued the new science with his philosophical spirit, while J. Loeb (1891) attacked similar problems from a physiological point of view. Soon Morgan, Wilson and Herbst joined these pioneers and this line of work henceforth made itself felt also in all of Boveri's.

After some smaller papers, dealing with experiments relating to the theory of mitosis, he published in 1899 a full account of the facts relating to the diminution of the chromosomes, long since discovered by him.[2] To make all the facts clear he had to give a full account of the cell-lineage of this worm, a line of work of the greatest importance since the discoveries of Wilson and Conklin in the early nineties (although the foundations of this line of work date back to the investigations of Rabl, Van Beneden and Whitman, as is well known). The facts were in harmony with the results of Zur Strassen, which had in the meanwhile been published.

[2] "Die Entwicklung von *Ascaris megalocephala* mit besonderer Ruecksicht auf die Kernverhaeltnisse," Festschr. f. C. von Kupffer, 1899.

The year 1900 brought the fourth part of the Zellstudien, with the subtitle "Ueber die Natur der Centrosomen." The thirteen years which had passed since the publication of the first fascicle had seen an immense accumulation of morphological and physiological facts regarding the various parts of the cell, especially the chromosomes and the centrosomes. The importance of these latter for the mechanism of cell-division was already recognized by Buetschli as early as 1876, in spite of the fact that he did not realize them as distinct bodies. Flemming made this discovery, the significance of which was realized, however, only when Van Beneden and Boveri had discovered the life cycle of these bodies and recognized them as permanent organs of the cell, and after Boveri had pointed to their important bearing on the theory of fertilization. Since that time a vast accumulation of knowledge concerning the centrosomes had been acquired through the work of Brauer, Coe, Griffin, Haecker, Heidenhain, Kostanecky, Lillie, MacFarland, Mead, Meves, Van der Stricht, Vejdovsky, Wilson and others. Boveri now deals with all the questions which had been raised, adding a series of new facts about the life cycle of the centrosomes in different objects. He discusses the question of the nuclear origin of the centrosome in the male sex cells of *Ascaris*, discovered by Brauer and confirmed by Boveri's pupil Fuerst. Then came the question of the persistency of the centrosome in non-dividing cells according to Heidenhain, and the centrosome theory of the basal bodies of ciliary cells as developed by Henneguy and Lenhossek. Great importance was attributed to the question regarding the phylogeny of the centrosomes, discussed at this time in connection with the discoveries in Protozoa by Buetschli, R. Hertwig, Blochmann, Schaudinn and Calkins. Further he deals with the rôle of the centrosome in the mechanism of cell-division, which had been discussed broadly from a physical standpoint during these years by Buetschli, Heidenhain, Rabl, Ziegler and Rhumbler, and defends his old earlier viewpoint. Then he refuses Fischer's destructive criticism of the methods of microscopical re-

search; and finally tries to bring his views into accord with Morgan's discovery of the artificial astrospheres and Loeb's artificial parthenogenesis. Much space is devoted to the question concerning the relation of centrosome and centriole, a subject which is no longer considered of great importance. In connection with this paper may be mentioned his address before the Versammlung Deutscher Naturforscher und Aerzte 1901, "Das Problem der Befruchtung," where he again puts forward his centrosome theory of fertilization and endeavors to reconcile it with Wilson's new work upon the cytology of artificial parthenogenesis.

In 1903 Boveri published a preliminary report of his work upon multipolar mitosis, which investigation is, in the writer's opinion, the acme of his cytological work. Fol and O. Hertwig had discovered the simultaneous division of dispermic sea-urchin eggs into four cells. Driesch had separated these four blastomeres and raised stereoblastulæ from them. Boveri now uses this method for attempting to analyze the different qualities of the chromosomes in one cell. He demonstrated that the four cells derived from a tetraster-division may get every possible combination of the 3×18 available chromosomes; and that the distribution of normality or deficiency in the plutei raised from the isolated cells corresponds exactly to the probable content of the cells in regard to a complete or incomplete set of the qualitatively different chromosomes. These facts are to-day so well known to every biologist that they do not need to be exposed further. But it might be said that the full account of the work published in 1908 as Zellstudien VI., shows Boveri's analytical genius from its very best side; the reading of this work is a highly intellectual and esthetical pleasure. There may be incidentally mentioned here a short paper on the influence of the sperm on the larval characters of Echinids.[3] This paper based on hybridization experiments proves, contrary to the views of Driesch, that all larval characters are influenced by the sperm cell.

[3] Roux's Archiv, 16, 1903.

The same year Boveri reviews before the German Zoological Society the knowledge "Ueber die Constitution der chromatischen Kernsubstanz," a lecture that made a great impression on his hearers through his usual crystalline clearness and keen analysis. It is remarkable because he accepts here unreservedly the recently published hypothesis of McClung regarding the accessory chromosomes as sex-determiners; further, Suttons's analysis of the relation between the distribution of the chromosomes and Mendelian characters, a hypothesis which Boveri had conceived independently, but had not previously published, besides a brief remark pointing to his occupation with the subject. In this connection it might be said that it is characteristic of Boveri's work that important discoveries are mentioned in his papers occasionally, but not communicated *in extenso,* because he intended to work them out more fully later. So he always returns to his former observations after a great many years. Meanwhile there may have been done much work in the same line and ideas proposed from other sides, that he had himself in mind. And this often caused discussions about priority. So Boveri returned in 1905, in Zellstudien V., to his old discovery of 1889 that the size of nuclei in normal and merogonic larvæ of Echinids corresponds to the number of chromosomes they contain. The question of size relations between nucleus and cytoplasm had meanwhile become very important through the work of Gerassimoff (1902) and especially R. Hertwig (1903), who tried to base an analysis of many phenomena of cell-life on the assumption of a nuclear-plasmic relation. Boveri now had the ingenious idea of studying the relation between the number of chromosomes and nuclear and cell size by comparing the cells of Echinid larvæ experimentally produced with different chromosome numbers. There he had larvæ, called hemikaryotic, with the haploid number of chromosomes, obtained by artificial parthenogenesis (thelykaryotic) or by merogony (arrhenokaryotic); further, the normally fertilized, diploid or amphikaryotic larvæ, with the normal number of chromosomes, *i. e.,* twice

as many as the foregoing, then diplokaryotic larvæ, again with twice as many chromosomes as the last, produced by artificial suppression of the first cleavage figure. Now by comparing these larvæ he found that the surface of the nuclei is proportional to the number of chromosomes contained in them; that the size of the cell is again proportional to both; and that the number of the cells in the same stage is inversely proportional. It does not need to be said that he discussed all consequences from these facts, in their different aspects. It is well known that these discussions are still going on, especially in connection with the work of R. Hertwig and his pupils and of Conklin.

The ever-growing tree of cytological research had meanwhile developed another flourishing branch. Henking had discovered (1891) the facts about the accessory chromosomes without understanding their importance. The studies of Montgomery and Sutton again revived in the beginning of the century the interest in these facts. McClung recognized in 1902 their importance for the sex-problem, and the work of Miss Stevens and especially Wilson brought the most surprising clearness. Boveri immediately became interested in these questions and suggested to some of his students lines of work in that direction. In 1909 he reported before the "Physikalisch-medizinische Gesellschaft" in Wuerzburg, where practically all his discoveries were first communicated, Miss Boring's work, discovering the very important *Ascaris* type of sex-chromosomes; further about von Baehr's work, who cleared up simultaneously with Morgan the interesting behavior of the sex-chromosomes in the male cells of aphids; further about Gulick's studies on the sex-chromosome cycle of Strongylids, especially important because he was the first to work out in detail the conception that sex-linked characters are carried by the x-chromosome; finally Baltzer's work about sex-chromosomes in female Echinids (which later had to be revoked after Tennant's work). Boveri himself studied the sex-chromosomes in hermaphroditism (1911) and succeeded, simultaneously with Schleip, in bringing the facts in harmony with the general conceptions; the object was the nematode *Rhabditis nigrovenosa,* which shows an alternation between hermaphroditic and bi-sexual generations.

The last years of Boveri's life gave to us three more papers in the general field of cytology, each one showing him still at the summit of his intellectual strength. The first, "Ueber die Charaktere von Echinidenbastardlarven bei verschiedenem Mengenverhaeltnis muetterlicher und vaeterlicher Substauzen" (1914), gives a very fine analysis of the relative importance of protoplasm and nucleus in the inheritance of characters. By comparing hybrid larvæ with different qualities of both (developed from giant-eggs, fragmented eggs, isolated blastomeres) he reaches the conclusion that the chromosomes are responsible for the characters of the larvæ (in agreement with Baltzer and Herbst and opposed to Godlevski). In the second paper, "Zur Frage der Entstehung maligner Tumoren" (1914) we find Boveri in a field at first sight far distant from his usual line of work. But only apparently. In his former analysis of the chromosomes in multipolar spindles he had already pointed to the possibility of explaining the sudden origin of malignant tumors and their behavior by the assumption that they originate from cells with abnormal combinations of chromosomes resulting from an occasional multipolar mitosis produced by some influence in the surrounding medium. As he believes that this idea, very closely connected to von Hansemann's cancer-theory, might be useful for further research, he works it out here in extenso and discusses its merits in regard to the facts of pathology. The third paper finally, and the last one published by Boveri during the summer 1915, deals again with a subject, discussed by him 27 years before, namely, the origin of Siebold's famous gynandromorphic bees from the Eugster hive. Boveri was able to secure the original material and to work it through in order to determine whether his old hypotheis of 1888 or those of Morgan (1905) or Wheeler (1910) was correct. By means of a very beautiful analysis he shows that his

own hypothesis—fertilization of one nucleus after a premature division—is the only one in agreement with the facts.

It has already been said that Boveri's cytological work was always intermingled with studies in experimental embryology. His favorite objects, sea-urchin egg and *Ascaris* embryos urged him to work out problems in that line. There may be mentioned only two of his most successful pieces of work. One of these deals with the polarity of the sea-urchin egg. Selenka and Morgan were already acquainted with some of the facts, and the work of Roux, Driesch and Wilson had brought the discussion of egg-axes, regulation and equipotential systems, to the foreground. Boveri (1901) now is able to demonstrate morphologically the polarity of the sea-urchin egg—the well-known pigment ring—and to point out in a series of experiments how this preformed polarity explains all the previous results regarding the development of isolated blastomeres, fragmented eggs, deformed germs and larvæ with dislocated blastomeres.

The second series of experiments—partly done in connection with two of his students (Miss Stevens and Miss Hogue)—deals with the potency of the *Ascaris* blastomeres, studied especially with the centrifuging method and in cases of dispermia. His paper, "Die Potenzen der Ascarisblastomeren," in R. Hertwig's Festschrift, 1910, constitutes another high-water mark of his work. He mixes the plasmatic content of the eggs by centrifuging them and combines this in other cases with destroying one of the first blastomeres with ultraviolet rays. Then he follows with great accuracy the cell-lineage and reaches through a wonderful analysis the quite unexpected conclusion that in these eggs with strongly determinate cleavage nothing like organbildende Keimbezirke can be present, and that these eggs are very probably to be regarded as a "harmonious-equipotential system." In the same paper he gives an answer to another question, which had vexed him, since he first entered the field of cytology, namely, the cause of the diminution of the chromosomes in the somatic cells. By a most remarkable analysis he reaches the conclusion that the constitution of the protoplasmic surroundings is alone responsible for the process.

Besides all this closely correlated work, Boveri only once—with the exception of his doctor's thesis—entered a quite different field of research. The result was his paper on the nephridia of *Amphioxus,* one of the classics of vertebrate morphology (1892). His discovery of the protonephridia of that famous animal, as the result of logical thinking and consequent observation, is well known to every biologist as well as the phylogenetic significance attached to it. In his later years he returned but once to this subject, following Goodrich's discovery of the solenocytes, but always retained a special interest in all questions concerning the *Amphioxus,* encouraging also the work in this direction done by his assistant Zarnik.

The number of papers published by Theodor Boveri is comparatively small, only about forty. But of these there are very few which could be called unimportant, and a surprisingly large number of them constitute landmarks in the progress of our science. This is to be explained by his way of working and thinking. If his ability is to be characterized in a few words, one might say he was keen, philosophic and artistic. Keen, in that his piercing intellect immediately saw behind a minor observation its far-reaching consequences, and followed them patiently to the last detail. Philosophic, as he followed his discoveries and put them in their proper place within the science of biology with an exact logic, sometimes almost striving at dialectics, and with the spirit of clearness and order. And last, but not least, artistic. The construction of his ideas has an almost esthetical beauty. And at the same time he was a master of the language. If he talked before a learned society he succeeded, in spite of his calm, almost monotonous speech, to fascinate everybody, through the clearness and thoughtfulness of his words, as well as through the wonderfully refined diction. His papers are written in the same spirit; few scientific treatises have been better written. And where he

could devote himself especially to the esthetic side of a paper, as in his wonderful Rector's address, "Die Organismen als historische Wesen" or in his necrologue on Anton Dohrn, he reached the state of literary perfection of a work of art. And these characteristics of his work were in full harmony with his personality. At first sight not remarkable, he immediately fascinated one through his eyes, flashing with genius. And those who knew him were aware how much the artistic side of life meant for him, who was more than an amateur in music and painting. He was not only a great scholar, but a noble, harmonious man. What he has been for our science may be said with the words that he himself dedicated to Anton Dohrn:

Er brauchte ja nur um sich zu blicken, um sich sagen zu muéssen, dass er der Biologie einen Impuls gegeben hat, dem wenige sich an die Seite stellen können, und dass seine Tat und mit ihr sein Name leuchten werden in der Geschichte unserer Wissenschaft, weit hinaus, wo nur die hoechsten Gipfel noch sichtbar sind.

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ARTHUR WILLIAMS WRIGHT

Professor Arthur Williams Wright died at his home in New Haven, Conn., on December 19. He was born on September 8, 1836, in Lebanon, Conn., where his father, Jesse Wright, at one time a member of the Connecticut House of Representatives, served as justice of the peace, selectman and a member of the school board. Samuel Wright, who settled in Springfield, Mass., in 1639, was his earliest paternal ancestor in this country. His mother was Harriet, daughter of William Williams and a descendant of Robert Williams, who came to this country from England in 1637, settling at Roxbury, Mass.

He received his early education in his native town, preparing for college, under William Kinne, at Canterbury. His career as an undergraduate at Yale College was a distinguished one. He not only achieved notable successes as a scholar in mathematics and astronomy, his studies of predilection, and in Latin, but he was prominent in undergraduate social life. A life-long love for music naturally led him to identify himself with the musical organizations of his time, and a critical knowledge of music, including an enviable skill in performance, added largely to the pleasures of his later and more leisurely life.

After graduation he continued his studies at Yale, specializing in mathematics and science, and acquired the degree of Ph.D. in 1861. From this time until his retirement in 1906 his life was identified with Yale except for a period in 1868–9, when he studied at Heidelberg and at Berlin, and the three years 1869–71 during which he held a professorship of physics and chemistry at Williams College. In the last named year he returned to Yale as professor of molecular physics and chemistry.

One of Professor Wright's most distinguished services to his university, and indeed to the teaching of science in America, was the early recognition that the practise of combining professorships of physics and of chemistry had ceased to be either economical or possible. It was, therefore, under his stimulus and activity that the first Sloane Laboratory of Yale College, the first structure in the country devoted exclusively to the work of a physical laboratory in the modern sense—was designed and constructed. This was completed in 1883, and henceforth he devoted his time, until his final retirement, to instruction and various physical investigations there, although the title of his professorship was not changed to that of molecular physics until 1887. This Sloane Laboratory also contained the study and lecture room of Professor J. Willard Gibbs, whose contributions to physical sciences have made it celebrated for all time.

The greater portion of Professor Wright's scientific work found its first publication in the *American Journal of Science*. These contributions are not merely important; they are characterized by rare excellence of form and of clarity. A short review of these papers will prove of interest.

"On a Peculiar Form of the Discharge be-

tween the Poles of the Electrical Machine," Vol. 49, 1870. This paper describes the glow produced upon the positive ball in an active electrical machine and the conditions under which it may be produced. The striking fact that each portion of this luminous surface can be regarded as due to the effect of a point area on the negative ball, as proved by sharp geometric shadows formed by minute obstacles anywhere within the region between the conductors, is quite new and it affords a particularly beautiful method of determining the shape and position of the lines of force.

"A Description of a Simple Apparatus for the Production of Ozone," Vol. 4, 1872, was followed by two studies of the chemical action of ozone. The first of these, "On the Action of Ozone upon Vulcanized Caoutchouc," Vol. 4, 1872, calls attention to the cause of the deterioration of the insulating properties of vulcanite and gives means of correcting the fault. The second paper, "On the Oxidation of Alcohol and Ether by Ozone," Vol. 7, 1874, is an application of his ozone apparatus to the chemical investigation indicated in the title.

In the same year Professor Wright published two papers on the "Zodiacal Light" and a note on his observations concerning the polarization of the light of Coggia's Comet, all of which are contained in Vol. 8. In the first of these papers the question of the polarization of the zodiacal light even to a fair determination of the ratio of polarized light to unmodified light, seems to have been definitely settled by the skilful use of a polariscope of his own design. So, also, his second paper, on the spectrum of the zodiacal light, appears to have determined once for all a discussion which had occupied many observers.

In Vols. IX. to XII., we find a series of papers, five in all, of great interest on the gaseous contents of meteoric irons and stones. In the first of these papers he reviews the known results of the investigations upon the occluded gases of meteoric irons, quoting Professor Graham and Professor J. W. Mallett. In his own investigations the material came for the most part from the collection in the possession of Yale University. His conclusions in this first paper were that no one of the several irons which he studied gave any spectroscopic evidences of unknown elements. The second paper is a brief one upon the gases derived from the meteorite of February 12 of this year, presented as a note preliminary to a farther study.

In Volume X., "Examination of Gases from the Meteorite of February 12, 1875," Professor Wright gives a thorough review of the gaseous contents of this meteor. It appears to be the first stony meteor thus investigated and the results are of great importance; they not only show the presence of gases occluded in stony meteors but that they are distinguished by having oxides of carbon as their characteristic gases, instead of hydrogen. He points out the bearing of these observations upon the peculiar spectra of comets and as a support of the meteoric theory of comets.

In Volumes XI. and XII. Professor Wright continued these important investigations, extending them to a considerable number of stony meteors of known origin. The earlier conclusion that stony meteors are characterized by a large amount of occluded carbon compounds was abundantly verified, and the last paper contains a long discussion concerning the bearing of these observations on the current theory of comets.

This terminates the series of papers on occluded gases in meteorites, but it is interesting to note that the mastery of the problems involved served him in an admirable piece of work five years later, published in Vol. XXI., 1881. The paper "On the Gaseous Substances contained in the Smoky Quartz of Branchville, Conn.," is sufficiently defined by its title, but the skill and success with which the investigation was carried out and its results presented makes the article a model worthy of careful study.

In 1877 Professor Wright published two important papers, in Vols. XIII. and XIV., respectively, on the deposition of metallic films by the cathode discharge in exhausted tubes. A clear description of the technique of the process and of the physical properties of a large number of metals thus treated makes the

papers of unusual interest. The intrinsic value of his method has proved so great that it is quite probable that the name of the author is more widely known from these scientific contributions than from any others published during his long and active life.

In the foregoing review of the scientific work of Professor Wright there has been no effort to do more than sketch the contents of the papers of chief importance, a large number of notes and minor contributions to science have been ignored. It would hardly be just, however, to fail to note his activities in X-ray experiments. At a time when Röntgen's discovery was hardly more than a rumor and the greater number of physicists, perhaps somewhat skeptically, were awaiting more definite descriptions of methods and results, Professor Wright immediately applied the test of experiment and secured the first of these photographs made in this country. This showed in a very striking way his command of all the resources of his science at the time; nor did he stop with a mere verification of the most wonderful features of the phenomena. He made many studies of the nature of the radiations and their reactions on various forms of matter, but, like other contemporary investigations, the results were hardly more than negative and he did not publish them in a permanent form.

Professor Wright was a fellow of the Royal Astronomical Society of Great Britain and of the American Association for the Advancement of Science; he was a member of the American Physical Society, of the National Academy of Sciences and of other learned societies.

C. S. H.

THE LOUTREUIL FOUNDATION

It is stated in *Nature* that the first distribution of this fund under the auspices of the Paris Academy of Sciences has been made.

The grants recommended fall into three classes:

1. To institutions specially mentioned in the will of the founder. The Natural History Museum, 1,000 francs for the continuation of researches on orchids undertaken by Professor J. Costantin, and 5,700 francs for the purchase of accumulators, and 4300 francs for a radiographic installation needed in the laboratory of Professor Jean Becquerel. The Collège de France, 4,000 francs to G. Gley, for the installation of an apparatus in his laboratory for the production of cold; 5,000 francs to L. Cayeux, for completing the equipment of his geological laboratory for petrographical researches; 2,400 francs to M. Müntz, director of the laboratory of vegetable chemistry of Meudon; 2,000 francs to L. Nattan-Larrier for the purchase of a centrifuge and incubator for cultures of microorganisms. As the provincial observatories are all attached to the universities which have already received a special legacy from M. Loutreuil, the council will only consider claims for grants relating to researches of a personal order. Under this head 3,000 francs is granted to M. Gonessiat, director of the Algiers Observatory, for the construction of an apparatus designed to measure the intensity of Hertzian waves and for a vertical seismograph. Polytechnic School, 3,000 francs to E. Carvallo, for the continuation of his researches on a method of shooting at airships. The veterinary schools of Lyons and Alfort, each 5,000 francs, for the upkeep of their libraries; the veterinary school of Toulouse, 3,000 francs for the same purpose, and 1,000 francs to M. Montane, for the reorganization of the anatomical collections of this school.

2. To institutions admitted by the president of the academy to participate in grants from the Loutreuil Fund. The Conservatoire des Arts et Metiers: 3,000 francs to Marcel Deprez, for his experiments relating to the transmission of the heat of gases to metallic walls, constantly cooled, and for experiments on electrical phenomena arising from internal-combustion motors; 4,500 francs to A. Job, for the purchase of a calorimetric bomb, an electric transformer, and other apparatus necessary to his researches on the velocities of oxidizing reactions; 6,000 francs to Jules Amar, for improving his equipment for the study of the muscular forces of man at work by the graphic and chronophotographic methods.

3. To other societies and to individuals. The Société de documentation bibliographique, 2,000 francs; 2,000 francs to Henri Piéron, for the equipment of his laboratory at the Sorbonne for physiological psychology; 2,400 francs to Louis Mengaud, professor at the Lycée of Toulouse, for exploratory work in the province of Santander; 10,000 francs to Charles Marie, for assistance in the publication of tables of physical constants; 3,000 francs to Camille Flammarion, for his private observatory at Juvisy; 4,000 francs to Emile Miège, for experiments at Rennes; 1,000 francs for the preparation of plates illustrating fossils collected by J. Couyat-Barthoux.

The total grants recommended amount to 82,300 francs, and this does not exhaust the sum available. During the war it has been impossible for all the investigators to carry on work already commenced or to undertake new researches, and other expenditure considered desirable by the council has been excluded by the terms of the legacy.

SCIENTIFIC NOTES AND NEWS

IVAN PAVLOV, the eminent Russian physiologist, died at Petrograd at the age of sixty-seven years. In 1904 he was awarded the Nobel prize for medicine.

SIR WILLIAM TURNER, principal of Edinburgh University, distinguished as an anatomist, has died at the age of eighty-three years.

DR. ELMER L. CORTHELL, of New York City, who has had charge of important work in bridge, railway, canal and harbor construction, has been elected president of the American Society of Civil Engineers.

DR. L. D. RICKETTS, president and general manager of the Canadian Consolidated Copper Company, has been elected president of the American Institute of Mining Engineers.

THE Academy of Natural Sciences of Philadelphia has elected as correspondents the following named: William Bateson, Charles E. Barrois, Thomas C. Chamberlin, Carl Diener, Alfred C. Haddon, Wilhelm Ludwig Johannsen, Stanislas Meunier, Albrecht Penck, William Trelease and Samuel W. Williston.

DR. EDWARD BAGNALL POULTON, Hope professor of zoology at Oxford University, has been elected a foreign member of the Swedish Royal Academy of Science.

DR. ALBERT EINSTEIN, of Berlin, has been elected a corresponding member of the Göttingen Academy of Sciences in the section of mathematics and physics.

THE gold medal of the Royal Astronomical Society has been presented to Dr. J. L. E. Dreyer, for his contributions to astronomical history and his catalogues of nebulæ.

A GRANT of $500 from the C. M. Warren Fund of the American Academy of Arts and Sciences has been made to Professor James F. Norris, of Vanderbilt University, for the study of factors which influence the valency of carbon.

C. A. MCLENDON, field pathologist of the South Carolina Experiment Station, has accepted a position as expert in cotton breeding with the Georgia State Board of Entomology, Atlanta, Ga.

DR. ALBERT ERNEST JENKS, professor of anthropology in the University of Minnesota, has returned after a leave of absence to study the question of mixed-blood Indians. Congress passed an act in 1907 allowing "mixed-blood Indians" on White Earth Reservation, Minnesota, to sell their lands. In time the government brought suit against citizens of Minnesota to set aside titles to certain lands, under the claim that the Indians who sold such lands were pure-blood Indians, instead of mixed-blood Indians. Dr. Jenks was called to attempt to settle the question of blood status by anthropometric methods. Of the nine court cases tried so far with anthropological evidence the court has held that the sellers in eight cases were mixed-blood Indians.

DR. H. L. SHANTZ, of the Bureau of Plant Industry, delivered the annual address before the local chapters of Sigma Xi and Phi Beta Kappa at the University of Nebraska on the evening of February 12, 1916. The subject of the illustrated lecture was: "Water as a Factor in Plant Growth."

Professor Douglas W. Johnson, of Columbia University, on February 11 addressed the United States Naval War College at Newport, Rhode Island, on "Topographic Features of Europe as a Factor in the War."

At the regular monthly meeting of the Cosmos Club, Washington, Dr. Charles Wardell Stiles delivered an address on "Some Medical Aspects of the Race Question in the South, with Special Reference to the Hookworm."

Dr. Julius Nelson, professor of biology at Rutgers College and state biologist, died suddenly at his home in New Brunswick, N. J., on February 16, from pneumonia. He was born in Copenhagen, Denmark, in 1858. He was a graduate of Wisconsin University, and received the doctorate of philosophy from the Johns Hopkins University. Dr. Nelson had been a professor at Rutgers since 1888.

Dr. John Wyllie, appointed professor of medicine in the University of Edinburgh in 1900, in succession to Sir Thomas Grainger Stewart, and retired owing to ill health in November, 1914, died on January 27.

The death has occurred at Copenhagen of Dr. Friedrich Krügen, director of the astronomical observatory at Aarhus.

Dr. J. C. Moberg, professor of geology at Lund, has died at the age of sixty-one years.

The U. S. Civil Service Commission announces an examination on March 21, for fish pathologist, for men only, to fill a vacancy at $2,500 per annum, in the Bureau of Fisheries, Department of Commerce. The duties of the fish pathologist are primarily to investigate the nature and the effects of diseases of fish or shellfish, physiological or environmental conditions associated with the development of pathological phenomena, and the means of prevention or cure. The investigation of stream pollution is involved as well as the study of the physical, chemical and biological conditions that may be salutary or deleterious to fish. Competitors will not be assembled for examination, but will be rated on education, experience and publications or thesis. Graduation with a bachelor's degree from a course in a college or university of recognized standing, and in addition at least one year of post-graduate work or the equivalent in chemistry or biology, are prerequisites.

According to information received via Buenos Aires, the magnetic-survey vessel *Carnegie*, under the command of Captain J. P. Ault, arrived at South Georgia Island on January 12, having made magnetic observations daily since her departure from Lyttelton, New Zealand, on December 6. Icebergs were encountered on nine days during the trip. The *Carnegie* sailed again on January 14, in continuation of her circumnavigation of the region between the parallels 50° and 60° south.

We learn from *Nature* that there is now at the London Library a small but very interesting exhibit of early printed books on astronomy, from the collection of Mr. Gilbert R. Redgrave. Many of them are from the press of Erhard Ratdolt, whose fine work at Augsberg and Venice is so well known. There is a splendid copy of a "Kalendar" by Monteregio (otherwise Regiomontanus), in Italian, and an even finer one in Latin, both printed by Ratdolt at Venice in 1476—works now of great rarity. There is also a very rare folio tract by the same author, "Universis Bonarum Artium Studi," printed at Nuremberg in 1476. These appear to be in absolutely perfect condition. Among other fifteenth-century books mention may be made of a fine copy of Hyginus, "Poeticon Astronomicon," of 1487, as well as the less rare edition of 1448. The diagrams of eclipses, etc., are frequently colored—some by hand and some printed in colors. Two works of later date, but of special interest, are Galileo's "Istoria e dimostrabioni," of 1613, describing the newly discovered spots on the sun, and announcing the configurations of Jupiter's satellites, and his "Dialogo" on the Ptolemaic and Copernican systems, which occasioned his condemnation by the Inquisition. The only English book is a fine copy of the first edition of Newton's "Principia" (1687).

The determination of the amount of water flowing in the streams of the Rio Grande basin, which covers the greater part of New

Mexico, large areas in southern Colorado, and a considerable territory in Texas and old Mexico, is of unusual importance to that region, for most of it is an arid agricultural country, entirely dependent on its streams for irrigation. Water Supply Paper 388, just issued by the United States Geological Survey, contains records for 1914 of the discharge of the Rio Grande and its principal tributaries, together with that of Colorado River of Texas and Brazos River. Systematic study of run-off in the Rio Grande basin was begun by the federal government near Embudo, New Mexico, soon after the passage of the act of October 2, 1888, which authorized the organization of the irrigation survey under the direction of the United States Geological Survey. A camp of instruction for hydrographers was established near Embudo, and at this camp and the gaging station near by the methods of stream measurement now in general use were systemized. In the spring of 1889 additional stations were established on the Rio Grande near Del Norte, Colo., and El Paso, Tex. From this beginning the work of measuring the waters of the Rio Grande basin has been expanded until there are now 40 gaging stations on the Rio Grande and its tributaries, Colorado River of Texas and Brazos. The report contains not only all data concerning stream flow collected in the western Gulf of Mexico basin by the survey and cooperating parties but also records furnished by private individuals and corporations. All stations in New Mexico were maintained in cooperation with the state. The United States Reclamation Service furnished a large part of the money expended in the lower Pecos River valley and also rendered assistance in the Rio Colorado, Rio Hondo and Rio Taos drainage basins. The United States Forest Service and the Indian Office also aided in the collection of data.

THE thirty-sixth Annual Report of the Director of the United States Geological Survey, just made public, emphasizes its scientific and economic activities. The survey investigations cover every branch of the mineral resources of a country whose mineral resources are the greatest in the world. The work of the survey is conducted under three scientific branches and includes three corresponding kinds of activity. Under the geologic branch, investigations are made concerning the mineral resources of the entire United States and Alaska, ranging from truly exploratory surveys of regions practically unknown to white men to the most detailed geologic examination of mining camps. Last year 76,000 square miles were thus geologically examined. Work of the survey that is even more of a pioneer type, however, is done by the topographic engineers, who have made surveys during the year in 30 states as well as in Alaska and Hawaii. The survey's topographic map is the base or mother map of the United States. The other scientific branch of the survey is that which conducts investigations of water resources, including the measurement of the volume of the important rivers of the country and their tributaries, as well as the study of underground water resources. Stream measurements are carried on from year to year, and the engineering data thus obtained are used in all kinds of hydraulic engineering, such as projects involving power, irrigation, drainage, and flood prevention. Another feature of the Geological Survey's work is the collection and publication of mineral statistics. Survey geologists are in correspondence with some 90,000 miners, mine operators, and mineral producers, whose output covers all the useful minerals, and the data thus obtained are published by the Survey in reports on seventy-five subjects. The total appropriation provided by Congress for the Geological Survey during the current year is approximately $1,500,000.

IN the joint statement given out by the United States Geological Survey and the Bureau of the Mint the value of new gold added to the home supply from mills and smelters operating on domestic ores (including those of Alaska, the Philippines and Porto Rico) in 1915 was $98,891,100. This shows the substantial increase of $4,359,300 over the output of $94,531,800 in 1914, and was within $782,300

of the record production of $99,673,400 in 1909. The gold-mining industry was generally prosperous again in 1915, according to figures compiled by H. D. McCaskey, of the United States Geological Survey, from preliminary reports received from the mines. Estimates made from these figures, which represent ores sold or treated during the year, as distinguished from the metal actually produced, show that the output was even higher, and that it approached, if it did not actually pass, the $100,000,000 mark; but some of the ore and concentrates produced from the mines and mills can not be smelted until 1916, and the refined gold did not become available for consumption in 1915. An increase in the yield of gold is indicated by the mine returns from every important gold-mining state, and a decrease is reported only from Washington, while the output of Idaho remains the same. The principal increases were nearly $2,500,000 in Colorado, over $2,200,000 in California, over $1,100,000 in Alaska, over $800,000 in Montana, nearly $650,000 in Utah, over $480,000 in Nevada, and over $300,000 in New Mexico. Smaller increases were reported from Oregon, South Dakota and Arizona. California retained first rank in 1915, with an output of about $23,000,000, and was followed by Colorado, with over $22,000,000; Alaska, with nearly $17,000,000; Nevada, with nearly $12,000,000; South Dakota, with over $7,000,000; Montana, with nearly $5,000,000; Arizona, with over $4,000,000; Utah, with over $3,500,000; Oregon, with nearly $2,000,000; New Mexico, with nearly $1,500,000; and Idaho and the Philippines, with about $1,200,000 each.

Preliminary estimates of the total yield of petroleum for 1915 indicate a slight increase over the record-breaking yield in 1914. This condition does not agree with the currently reported reason for the exceptionally high prices now prevailing for motor fuel. As a result of the over-load put on the transporting and refining phases of the petroleum industry by the excess output of crude petroleum in 1914, the year 1915 may be characterized as a period of readjustment in which production activity was purposely retarded as far as practicable. The small increase therefore is more significant than the simple figures suggest. According to John D. Northrop, of the United States Geological Survey, the marketed production of petroleum in the United States in 1915 approximated 267,400,000 barrels, and the total yield approximated 291,400,000 barrels, about 24,000,000 barrels of oil brought to the surface during the year being placed in field storage by the producers. The following table shows by states the marketed production of petroleum in 1914 and an estimate of the corresponding production in 1915, in barrels:

States	1914	1915
California	99,775,327	89,000,000
Oklahoma	73,631,724	80,000,000
Texas	20,068,184	26,000,000
Illinois	21,919,749	18,500,000
Louisiana	14,309,435	18,500,000
West Virginia	9,680,033	9,000,000
Pennsylvania	8,170,335	8,700,000
Ohio	8,536,352	7,900,000
Wyoming	3,560,375	4,200,000
Kansas	3,103,585	3,000,000
Indiana	1,335,456	1,000,000
New York	938,974	900,000
Kentucky	502,441	450,000
Colorado	222,773	200,000
Other states	7,792	50,000
	265,762,535	267,400,000

Secretary of Commerce Redfield has addressed to the Secretary of the Navy the following letter relative to the success of the Bureau of Standards in developing a radio-direction finder.

Recent quotations in the press from your letter to the Senate Committee on Naval Affairs give part of a report from Admiral Fletcher in which it is said that among the needs of the navy is a radio-direction finder. The Bureau of Standards has been investigating this subject for some time and has developed an instrument which is simple and practical and at the same time very efficient in operation. It indicates the direction of the source at the same time that the messages are being received, and while it is very sensitive to radiations in a given direction it is less affected by atmospheric disturbances and interfering radiations from other directions than an ordinary receiving apparatus. We have received messages by one or another of the three sizes of instru-

ments that have been built from Philadelphia, Boston, Glace Bay, Newcastle (N. B.), New York, Norfolk, New Orleans, Panama, Key West, San Diego and Hanover, Germany. When atmospheric disturbances have been very pronounced on the large antenna at the West Laboratory, they have been very slight on the direction finder apparatus, which is entirely indoors, having no antenna or earth or other outside connection. This apparatus appears to be well adapted to use (*a*) on merchant and naval ships to obtain the direction from any lighthouses or lightships that may be equipped with radio fog signaling apparatus, (*b*) to obtain the direction of one ship from another at sea, (*c*) to communicate between ships or ship and shore stations irrespective of direction by reducing interference and atmospherics, (*d*) to use by the War Department in field service, as the receiving apparatus is portable and requires no ground or antenna, and can be carried readily in a light vehicle or even by a single observer, (*e*) to use by the Coast Guard Service to receive distress signals and locate the direction, (*f*) for use by the Bureau of Navigation to locate amateur or other stations that are not observing the radio regulations or are otherwise interfering with radio-transmission of the government or legitimate commercial business. The Bureau of Standards is prepared to demonstrate the apparatus to representatives of the War and Navy Departments or other interested departments at any time desired.

UNIVERSITY AND EDUCATIONAL NEWS

AN anonymous gift of $10,000 for surgical research at Columbia University has been announced by the trustees.

MORSE HALL, erected in 1890 and containing Cornell University's valuable chemical laboratories and scientific equipment, was destroyed by fire on February 13. The loss is estimated at $300,000, partly covered by insurance. The cause of the fire has not been determined.

THE board of trustees of the Ohio State University have ratified the proposal made by President W. O. Thompson for the establishment and maintenance of research professorships. The plan provides that men of recognized ability may be relieved from teaching to devote their entire time to scientific research.

DR. GORHAM BACON has tendered his resignation as professor of otology in the College of Physicians and Surgeons, Columbia University, to take effect at the close of the present academic year.

To fill the vacancy caused by the resignation of Dr. William J. Means, dean of the College of Medicine of the Ohio State University, Dr. Eugene F. McCampbell, secretary of the state board of health, has been appointed to the deanship.

DR. WALDEMAR SCHLEIPP, associate professor of zoology at Freiberg, has been called to the chair of comparative anatomy at Würzburg, vacant by the death of Th. Boveri.

DISCUSSION AND CORRESPONDENCE

SCHOOL AND THE LONG VACATION

THERE is a widespread belief shared by those working in the pedagogic field and those on the outside that something is radically wrong with our educational methods. The results achieved in schools and colleges are in no way proportionate to the native intelligence, the expenditure of effort in teaching and the stupendous outlay of money represented by material equipment and cost of maintenance. Employers of labor in stores, shops and factories complain of the lack of training and efficiency in the young men and women available for hire, and college teachers of sound judgment seem quite generally convinced that the average student at the end of his four-years' course has not enough to show in cultural attainments and useful knowledge. As I have intimated, this disappointing result is not due to lack of ability on the part of the American youth, who for quickness of perception and capacity of learning are not outclassed by the youth of any nation. The fault lies elsewhere. It would carry me too far from my present purpose were I to enter upon a discussion of all the defects of our system. I intend dealing with one only, a definite concrete condition easily comprehended and fully remediable if once educators are impressed with its significance.

The fault I have in mind has to do with the long summer vacation. In my opinion this is placed in an entirely false relation to the school year. Long-established custom has fixed it in elementary and secondary schools, in colleges and universities between two separate and independent school years. The student finishes a course and drops books and habits of study for a period varying from two to nearly four months. At the end of the vacation he returns to a new class, to new teachers, to new studies. It takes him a considerable time—in the professional schools of a university, as I know from my own classes, from a week to ten days—until he gets properly oriented, which still further increases the unused hiatus.

I am not criticizing the length of the vacation. In our climate it is almost a necessity for teacher and student to have surcease from school work during the long heated term; but I believe the vacation is wrongly placed. It ought to come within the school year, not at its close. In its present position there can be no work assigned, for, speaking generally, the teachers of the completed year have no control over the student in the year he will begin in the autumn. If a student is industrious he may carry on work in the continued branches, but will do and can do little or nothing as regards new studies—Greek, higher mathematics, physiology or what not—in the mysteries of which he has not yet been inducted. The loss in momentum and direction is tremendous, and if we add it up for all the vacations during school life from the first year to graduation from the university this potential loss becomes vast and staggering.

What is the remedy? There are two; one is the all-year-round school such as is in vogue in the University of Chicago, with its four trimesters. In the South and the mid-Atlantic region, a summer trimester is almost out of question. It would, for example, be well-nigh impossible to keep all the departments of a university in full swing during July, August and September. There is another remedy, and that I want now to propose. I would not do away with the long vacation, but I would place it in the mid-period of the school term, by making the scholastic year begin in February or March instead of in September. The school year would end in February with promotions and graduations and a new year would begin after a brief recess of not more than ten days or a fortnight. The student would remain in the new class for at least three months before the summer holiday, more than enough for a good start. The long vacation might then be utilized for valuable and purposive study, partly assigned, partly optional.

I am aware of the existence of a certain pedagogic prejudice against burdening children with school work during the long vacation. What I am advocating is not the projection of the school year with its tasks and mental circumscription into the vacation, for I myself believe that one of the advantages of our long recess is that it gives the child's individuality a chance to develop. I maintain, however, that the assigning of a small amount of work does not interfere with the child's freedom. In the lower grades a very small amount suffices to keep up an interest and to preserve a continuity of thought, which is all that we need strive for. In the case of older pupils and certainly of college students we could well ask not merely the preservation of the mental *status quo* but enough work, proportionate to the length of the vacation, to carry the student a little beyond where he left off—and this again without materially infringing on our youth's traditional claim to a carefree holiday. When student and teacher meet in the fall, work could commence at once with the accumulated energy resulting from a sane combination of work and play during the summer. There would be no loss, but instead a great gain in momentum. Consider the totality of gain in the period from the first grade until the close of the four years' college course, a matter of fourteen or sixteen years.

The change I have suggested is applicable to all schools, elementary, high school, college and university, and can be brought about without doing any violence to the fundamental principles of our educational system. I know of no other reform comparable to this in prac-

tical feasibility that promises such great results.

DAVID RIESMAN
UNIVERSITY OF PENNSYLVANIA

A PLAN FOR COOPERATION AMONG THE SMALLER BIOLOGICAL LABORATORIES

SECOND thought is hardly necessary for a realization of the fact that the scientific laboratories of the smaller colleges throughout the country suffer greatly from their isolation, from the overworked condition of the instructor, and from the indifferent quality of the materials for daily use in the ordinary courses in zoology, botany or general biology. Such conditions, furthermore, have a habit of continuing thus unchanged throughout the years, much to the vexation of the instructor as well as to the detriment of the many students, in the aggregate, who take the various courses.

Although the complexity and expense of thorough laboratory equipment are both unlimited, it is yet evident that the prime desiderata for the giving of the ordinary courses to undergraduates are fairly simple matters—a good culture showing large *Amœba proteus* in abundance, prepared slides stained so as to show mitosis plainly under a dry objective, and other similar items of equipment are matters simple to mention but far from being satisfactorily provided even in some of the better laboratories.

Some further conditions confronting the biologist in the smaller laboratory may be summarized as follows: The task of providing a set of slides satisfactory for illustrating the organology and histology of the earthworm is not so difficult a matter in itself but, when taken in connection with the preparation of many other needed series, it is obviously out of the question that the work be done thoroughly well. The result is either equipment good in quality but scanty in amount or, if the supply be adequate, the quality is low. At this point it is perhaps worthy of remark that the provision of class and demonstration materials for the use of elementary students requires a special talent of the preparator. The lack of special scientific insight characteristic of the average student makes necessary preparations as plain as to detail as they are lacking in special bias.

As a possible method for providing some of this equipment satisfactorily and from the scientist's, rather than from the dealer's, point of view it has many times occurred to us that a system of mutual aid among a league of the smaller laboratories might be established which would not only furnish a system of exchanges of material valuable for teaching and research purposes but which might also be conducive to scientific and educational benefits as well. The writer feels certain that many of the difficulties outlined above would be relieved by the method to be proposed, which, briefly stated, is as follows: For each of a number of laboratories to specialize upon the preparation of a different element of equipment as, for example, the culturing of protozoa or algæ, the collection and proper preservation of certain other available materials and, in particular, the preparation of histological or cytological slides high in value for the demonstration of general principles. A division of labor thus affected, special pains might be taken for the collection, fixation and staining of material of a definite sort in order that the very best results might be secured and in a field for which the special training of the biologist or the special development of his laboratory might reasonably be expected to add value to the product. The method once mastered the mechanical details of indefinitely repeating the process and so providing a supply for others at work upon other tasks might be carried on by almost any undergraduate assistant.

Concentration of effort upon a task of this sort might easily result in a surprisingly high quality of a certain preparation even from a laboratory of small size and very modest equipment, and conversely the returns from the establishment of the system in benefits from other institutions might safely be depended upon to steadily affect a marked improvement in the quality of the courses offered.

Geographical advantages might also be de-

pended upon to enhance the value of the factor of equipment undertaken by any certain laboratory.

A definite statement of the objects to be sought as well as regulation of the various activities would, of course, be necessary, as well as the establishment of a basis of values and rules governing exchanges of materials which might or might not be for monetary considerations. The establishment of such regulations could well be placed in the hands of a secretary or committee of the parties to the agreement.

J. P. Givler

Southwestern College,
Winfield, Kans.

SCIENTIFIC BOOKS

A Revision of the Cestode Family Proteocephalidæ. By George Roger LaRue. (Contributions from the Zoological Laboratory of Illinois, No. 33.)

The graduate school of the University of Illinois is to be congratulated on the publication of this monograph, which, we are informed, is a "Thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy."

Dr. LaRue has, in this thesis, made a contribution to the literature of helminthology of a kind that is much needed. He has performed the drudgery of examining the literature of his subject with skill and patience and at the same time has achieved noteworthy success in bringing order out of confusion. The labor of identifying species by future investigators should be much lightened on account of this contribution.

The monograph is a large volume of 350 pages and 16 plates containing 199 figures. The figures are simple line drawings, largely diagrammatic, but, so far as the writer has tested them, clear in diagnostic features and free from confusing or unnecessary details. Methods of technic are incorporated in the introduction, which should be of value to prospective workers on the anatomy of the cestodes. Hematoxylin mixtures are found to yield more satisfactory results than carmine. "It is noteworthy that the carmine stains give beautiful preparations of trematodes in toto, but fail almost entirely for cestodes. For the cestodes these stains fail because they do not sharply and clearly outline the sexual organs as they do in the trematodes, though not better than do the hematoxylins. In the judgment of the writer the use of carmine stains in cestode material has been responsible for many errors in the interpretation of cestode structures." An important introductory section deals with the anatomy and histology of the Proteocephalids. In this section the literature of this phase is reviewed critically. It is interesting to note that while insisting that the anatomy and finer structure of the internal organs furnish the most valuable characters for diagnostic purposes, the author remarks that more value should be given than is given to data as regards the host, the locality and habitat of the host, which data are always of value.

The insertion of a key to the better known genera and species of Proteocephalidæ is to be highly commended. The literature of the Cestoda is much scattered and there is need of synopses and keys if acquaintance with the distribution of species with all that goes along with that knowledge is to be extended and made accurate.

The bulk of the monograph is made up of the description of species of Proteocephalids, of which there are 33 from fishes and 18 from amphibians and reptiles. These descriptions are, from the nature of the case, of unequal proportions. For example, *Proteocephalus filicollis* (Rudolphi) and *P. torulosus* (Bartsch), neither found in this country, are given about eleven pages each. Extracts are made from French and German authorities and from the Latin of Rudolphi. There is perhaps justification in these instances for inserting descriptions in the languages in which they were originally written, although as a general practise the reviewer would advise against it. LaRue has not been content with simply reviewing the literature of such species as those just mentioned, but has studied material obtained from European helminthologists, and, having had the use of Dr. Ward's extensive collection, has been able to review the literature with an intelligence and authority that inspires confi-

dence in the reader. Other species, as, for example, *P. cyclops* (von Linstow), *P. nemetosoma* (Leidy) and *P. salvelina* (Linton), are given less space, such being, as a rule, records of material that either did not admit of certain identification, or at least were inadequately described. Such species as *P. ambloplites* (Leidy) and *P. perplexus* (LaRue), which are American species and have been studied by the author, are described in detail, and with such discrimination that there should not be any confusion in future identifications of these forms. Comparative tables of selected characters of Proteocephalid species are given. Such tables are of peculiar value in the identification of such soft-bodied forms as cestodes and trematodes, whose superficial appearance is affected diversely by preserving fluids. Under distribution it is of interest to note that amphibian Proteocephalids are known only from the two continents, North America and Australia, while those of reptiles and fish are known from all the continents.

The following conclusions are of general interest:

1. A species of *Proteocephalus* may occur in different host species of the same genus. Five species are limited exclusively to various species within the same host genus.

2. A species may occur in the different genera of the same family.

3. A species may occur in the members of closely allied genera, *i. e.*, of the same order. Four cases are known.

4. A species may occur in families of very wide relationship, *i. e.*, of different orders. There are two cases, of which one is doubtful.

A further general statement is: The parasitic infestation of the host is determined by the food eaten.

A suggestive fact, pointing to a wide and fruitful field of investigation, is indicated when it is noted that in this monograph of 350 pages less than 2 are devoted to the life histories of the Proteocephalidæ, and these pages are largely taken up with a discussion of probable life histories.

As to the relationship of the Proteocephalids to other cestodes, the author finds that structurally they are to be considered as being closely allied to the Tetraphyllidæ, while their relationship to the Cyclophyllidæ is distant. The inclusion and long retention of the Proteocephalids in the great genus *Tænia* was due to external features alone.

The origin of the Proteocephalids is discussed and the suggestion made that it may have been some member of the family Lepisosteidæ that is responsible for the introduction of these cestodes into the fresh-water environment.

A bibliography of 78 authors and 144 titles is appended. These range in time from 1766 to 1912.

EDWIN LINTON
WASHINGTON AND JEFFERSON COLLEGE,
WASHINGTON, PA.,
January 22, 1916

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of Vol. 17 of the *Transactions of the American Mathematical Society* contains the following papers:

W. F. Osgood: "On functions of several complex variables."

E. B. Van Vleck and F. H'Doubler: "A study of certain functional equations for the θ-functions."

B. A. Bernstein: "A set of four independent postulates for Boolean algebras."

L. P. Eisenhart: "Transformations of surfaces Ω (second memoir)."

E. J. Moulton: "On figures of equilibrium of a rotating compressible fluid mass; certain negative results."

THE February number (Vol. 22, No. 5) of the *Bulletin of the American Mathematical Society* contains: Report of the ninth regular meeting of the Southwestern Section, by O. D. Kellogg; "A note on the problem of Lagrange in the calculus of variations," by G. A. Bliss; "Concerning a non-metrical pseudo-archimedean axiom," by R. L. Moore; "A type of singular points for a transformation of three variables," by W. V. Lovitt; Review of Goldenring's Die elementargeometrischen Konstruktionen des regelmässigen Siebzehnecks, by R. C. Archibald; "Shorter Notices;" Wentworth and Smith's Plane Trigonometry and Tables

and Horsburgh's Modern Instruments and Methods of Calculation, by C. C. Grove; Longley's Tables and Formulas, revised edition, by Joseph Lipka; Enriques' Vorlesungen über projektive Geometrie, second German edition, by A. Emch; Miller's Descriptive Geometry, Armstrong's Descriptive Geometry, and Grossmann's Darstellende Geometrie, by Virgil Snyder; "Notes;" and "New Publications."

SPECIAL ARTICLES

AN APPARENT LATERAL REACTION BETWEEN IDENTICAL PENCILS OF LIGHT WAVES, CROSSING EACH OTHER AT A SMALL ANGLE[1]

1. *Methods.*—To exchange the component beams in the interferometer, to mutually replace the two pencils which interfere, is not an unusual desideratum. To replace two pencils of component rays travelling more or less parallel to each other, by pencils more or less normal to each other, to be able to operate at the point of intersection of corresponding pencils of rays from the same source, crossing at any angle, may be of interest in a variety of operations and may even suggest novel experiments.

In Fig. 1, I have sketched one of many forms of apparatus of the kind in question, with which I have recently been working. A beam of parallel rays from a collimator, L, impinges on the reflecting plate grating G. The diffracted pencils a, b, are reflected by the opaque mirrors n and m into b' and a', to be again reflected by the opaque mirrors M and N into the pencils b'' and a''. These impinge on the plate grating G', so placed that both pencils are diffracted along the same direction $G'T$, into the telescope at T.

If now the opaque mirrors m, n, M, N, are appropriately rotated, the parallel component beams $GmMG'$ and $GnNG'$ may be replaced by $GmNG'$ and $GnMG'$, respectively, which cross each other at c, while the pencils impinging at G' have been exchanged.

There is an essential difference in these two cases. Whereas in the case of parallel rays, a', and b', the double diffraction is an increment of either, in the case of the crossed rays, a and b, it is a decrement and the system tends to become achromatic. In the latter case one should suppose that homogeneous light and a wide slit only could be used in the interferometer. But this is not so.

2. *Results.*—The reflecting gratings with large dispersion constants in my possession waste too much light and the work is thus burdensome. The following results were

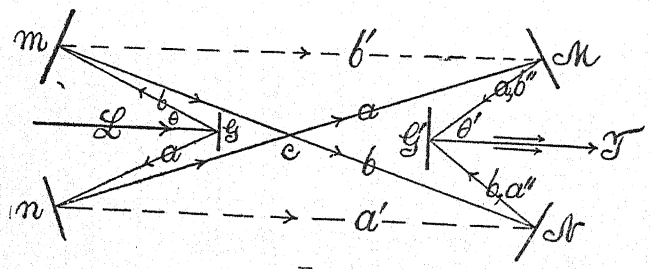


Fig. 1.

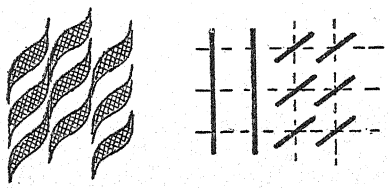
therefore investigated with a good ruled transmitting grating, adjusted to secure the double diffraction of Fig. 1 in a single grating. This simplifies the method and the interferences are much more expeditiously found. The rays in such an apparatus must cross in the glass plate of the grating at c.

In the case of parallel rays Nn, Mm, white light and a fine slit, I obtained the linear phenomena of reversed spectra as usual. On using homogeneous light and a wide slit superb interferometer fringes were obtained. In every instance these are parallel striations crossing the whole field *uniformly*. They may easily be made coarser or finer, or rotated at pleasure, but a given field never shows independent groups; *i. e.*, there is no second periodicity

[1] Work done on a grant from the Carnegie Institution of Washington, D. C.

distinct from the first. In the case of crossed rays *mN* and *nM*, however, a uniformly striated field is only incidental. There is always a second periodicity present, distinct from the first, even if concealed. The striations are grouped in parallel strands. It is now quite possible to obtain the linear phenomenon with a wide slit and the occurrences, when homogeneous light and the wide slit are used, are merely a rhythmic reproduction of the linear phenomenon, parallel to the slit; *i. e.*, transverse to the spectrum.

To make this clearer, suppose the original or regular striations are vertical and that sodium light is used. Then the typical pattern is of the kind shown in Fig. 2*a*. It looks like a parallel set of thick twisted cords, hung side by side and equidistant. It is often much more complicated, though adhering to this de-



a *b* *c*

FIG. 2.

sign. The evolution of this pattern is obtainable on moving one of the slit images in the field in different amounts micrometrically over the other, keeping the longitudinal axes of the spectra in coincidence. Then if the fringes are originally nearly vertical apparently uniform striations, figure 2*b*, they change by rotation into the form figure 2*c*, and at the same time enlarge. In other words, the lines *b* consist of individual parts, behaving similarly but independently, as if they were a set of magnetic needles. The same results may be obtained with the single strand of the linear phenomenon and white light and here the rotation may be carried through nearly 180°, between infinitely small sizes. It is fairly tumbling in its mobility when of maximum size and horizontal. Again, suppose the original regular fringes to have been horizontal and apparently uniform. Then if the phenomenon is made of maximum coarseness (there are two positions of the grating for which this occurs), on slightly passing one slit image of the other, to different degrees, micrometrically, the ap-

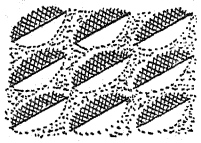


FIG. 3.

pearance presented is given in Fig. 3. The fringes have become nodules, half black and half brilliant, strung transversely like bean-shaped beads on parallel strings and hung vertically against a neutral (non-interfering) yellow background of sodium light. In incidental cases the black shadows may be a line, and the field is then an apparently uniform coarse grid; but generally they are separated as in Fig. 3. Sometimes the central strand is strongest and the intensity diminishes on the right and the left. More frequently the two central strands are equally strong. Five or six strands may be present. On moving the mirror *M* parallel to itself, these strands move to right or to left as a whole, in accordance with the equations of displacement interferometry. In fact, in view of the individuality of the strands, the apparatus is a useful displacement interferometer.

The occurrence of these parallel strands for crossed rays and homogeneous light is difficult to explain. I have tried a great variety of things (slightly wedge-shaped compensators and other methods of superposing special interferences, etc.) to produce them with parallel rays *mM* and *nN*, or to break them with crossed rays *mN* and *nM*, without avail. There is no focal plane effect, nor any polarization effect. It is therefore necessary to confront the case, at its face value, as in Fig. 4. Here *S* and *S'* are the traces of two vertical, longitudinally coincident, reversed spectra, drawn apart for distinction, the region of the *D* lines only being used. The light is homogeneous to this extent and the slit wide, so that there is oblique incidence. Then every point of *S* should (on adjustment) interfere with every point of *S'*, the result showing as a

uniformly striated field in the telescope. This is emphatically the case for the parallel rays, b' and a'; but with the crossed rays a and b

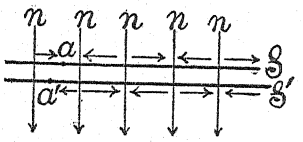


Fig. 4.

the interference is confined to the rays in the equidistant positions, n, in Fig. 4, and midway between them the field is a neutral yellow. In other words between the rays n, the rays are displaced laterally as shown by the arrows (recalling the arrangement of nodes in acoustics), so that corresponding rays a and a' for instance, do not coincide and hence can not interfere, the region aa' (Fig. 4) remaining neutral. In Fig. 5, the rays crossing at a vanishing angle have been shown for three ray filaments and the transverse arrows indicate the directions in which the rays have been urged, laterally. Naturally I am merely stating the case as suggested by the results.

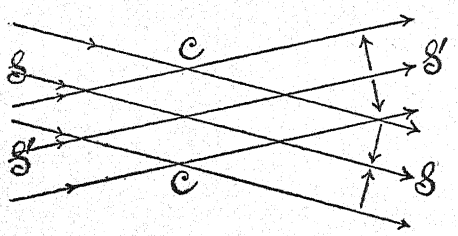


Fig. 5.

One may argue that there may be a secondary periodicity in the grating. But why does it not appear at all in the case of parallel pencils, when it is so obtrusive in the case of crossed pencils of rays? Again the interferences are unquestionably due to D_1 and D_2 light, simultaneously. If the grids in these two cases should be at a slightly different angle to each other, their superposition would give something like the observed phenomenon apart from details. With white light the linear phenomenon would eventually become achromatic. But why should lines so close together as D_1 and D_2 show any appreciable difference of angle in their interference pattern? Intersecting interference grids, moreover, can be produced by other methods and always betray their origin. The final inference is that suggested by Figs. 4 and 5, that homogeneous rays on crossing (here in a medium of plate glass) may exert a lateral influence on each other, to the effect that identical rays emerging from the crossing are arranged in equidistant nodal planes according to Fig. 4.

Carl Barus

Brown University,
Providence, R. I.

ANNUAL MEETING OF THE CHICAGO ACADEMY OF SCIENCES

On the evening of Tuesday, January 11, the annual meeting of the Chicago Academy of Sciences was held at the Academy building in Lincoln Park, Chicago.

The guest of honor and chief speaker was Director Frederic A. Lucas, of the American Museum of Natural History, and his address was entitled "The Service of the Museum to the Public."

The usual reports were received from the officers of the academy, and the results of the annual election were read. The officers for the ensuing year are: *President*, John M. Coulter; *First Vice-president*, Henry Crew; *Second Vice-president*, Stuart Weller; *Secretary*, Wallace W. Atwood; *Treasurer*, Henry S. Henschen.

Following the business meeting the members and guests were invited to inspect the new exhibit, which extends through the central portion of the main museum floor. It consists of one large case, 75 feet long and 20 feet wide. In this case, and supported from the ceiling, fifty-six of the larger birds of the Chicago region were installed as in flight. The exhibit is viewed from the main floor, and is 8 to 10 feet above the level of the eye, so that the birds are seen much as they might be under fortunate circumstances out-of-doors. One hundred and four habitat groups have now been installed in the Academy Museum to illustrate the natural history of the Chicago region. The birds, flowers, insects, reptiles and mammals are represented, and with the completion of this plan the museum will be unique in America, and have a special educational effectiveness.

Announcement was also made of the following course of open lectures:

February 11. "The Sun" (with illustrations), by Professor Philip Fox, Northwestern University.

February 25. "Liquid Air" (with demonstrations), by Professor Henry Crew, Northwestern University.

March 10. "Radium" (with demonstrations), by Professor H. N. McCoy, University of Chicago.

March 24. "Modern Views of Electricity" (with demonstrations), by Professor R. A. Millikan.

April 7. "Problem of Food Productions" (with illustrations), by Professor John M. Coulter, University of Chicago.

April 21. "Bacteria of the Alimentary Canal" (with illustrations), by Professor A. I. Kendall, Northwestern University.

WALLACE W. ATWOOD,
Secretary

THE ASTRONOMICAL SOCIETY OF THE PACIFIC

AT the annual meeting of the Astronomical Society of the Pacific, held in San Francisco, Saturday, January 29, 1916, the Bruce Gold medal for 1915 was presented to Dr. George Ellery Hale, director of the Solar Observatory (Carnegie Institution), Mt. Wilson, Pasadena, Calif., for distinguished services to astronomy. This medal was founded by Miss Catherine Bruce, of New York, in 1897 with a fund of $2,500, and in the past eighteen years has been awarded to thirteen astronomers.

The following astronomers who have been the recipients of the medal were:

Simon Newcomb, United States.
Arthur Auwers, Germany.
Sir David Gill, England.
Giovanni V. Schiaparelli, Italy.
William Huggins, England.
Hermann Carl Vogel, Germany.
Edward C. Pickering, United States.
George W. Hill, United States.
Jules Henri Poincaré, France.
J. C. Kapteyn, Holland.
O. Blacklund, Russia.
W. W. Campbell, United States.
George E. Hale, United States.

The nominations and the awarding of this medal are probably the most unique in the history of science. Six of the leading observatories in Europe and America, namely, Berlin, Greenwich, Paris, Harvard, Yerkes and Lick Observatories make the nominations. These are sent to the directors of the Astronomical Society of the Pacific, who make the final selection from these nominations for the gold medal.

Professor R. G. Aitken, astronomer, Lick Observatory, in his retiring president's address, paid a tribute to Dr. Hale's work, as a student, director of the Yerkes Observatory and the Solar Observatory, and in the problems of solar physics. The address will be published in full in the publications of the society.

The second address of the evening was given by Dr. H. D. Curtis, Lick Observatory, on the "Recent Theories of Stellar Evolution." This was followed by the election of officers for the ensuing year. *President,* Dr. S. D. Townley, Stanford University; *Vice-president,* C. S. Cushing, San Francisco; *Second Vice-president,* Dr. H. D. Curtis, Lick Observatory; *Third Vice-president,* A. H. Markwart, San Francisco; *Secretary-Treasurer,* D. S. Richardson, San Francisco.

THE BOTANICAL SOCIETY OF AMERICA

THE tenth annual meeting of the Botanical Society of America was held under the auspices of the Ohio State University at Columbus, Ohio, December 27–31, 1915, in affiliation with Section G of the American Association for the Advancement of Science, the American Phytopathological Society and the American Society of Naturalists.

The council for 1916 is as follows:

President—R. A. Harper, Columbia University.

Vice-president—Geo. T. Moore, Missouri Botanical Garden.

Treasurer—Arthur Hollick, Staten Island Association of Arts and Sciences.

Secretary—H. H. Bartlett, University of Michigan.

Councilors—David Fairchild, Bureau of Plant Industry; Wm. F. Ganong, Smith College; B. E. Livingston, The Johns Hopkins University.

One hundred and forty-six new members were elected, and an amendment to the constitution was passed which does away with the grade of "fellow" in the society. The membership of the society is now approximately 500.

The address of Retiring President A. S. Hitchcock, "The Scope and Relations of Taxonomic Botany," followed the *annual dinner for all botanists,* which was attended by 153 members of the affiliating societies. It will be printed in SCIENCE.

The following papers were given by invitation of the council, and will appear in the *American Journal of Botany:*

"The Specificity of Proteins and Starches in relation to Genera, Species and Varieties," by Professor Edw. T. Reichert.

"The Mechanics of Dormancy in Plants," by Professor William Crocker.

"The Periodicity of Freshwater Algæ," by Professor E. N. Transeau.

Joint sessions were held with Section G, American Association for the Advancement of Science and with the American Phytopathological Society, in addition to three general sessions of the society and two sessions of the Physiological Section. The titles and abstracts of the 69 papers follow:

The Bearing of Certain Senile Changes in Plants on Present Theories of Senility: H. M. Benedict.

Present theories of senility are based almost exclusively upon the study of senile degeneration in animal cells and organs.

Now that typical senile degenerations in *Vitis vulpina* and other perennial plants have been shown to occur, senility seems to be more inherently connected with living matter than was formerly supposed to be the case. Theories of senility, if true, must therefore be as applicable to senile degeneration in plants as in animals. The nine more common theories of senility are stated and classified, and examined in the light of the new data obtained from plants. Of these the theory, first advanced by Kassowitz (1899) and supported by Hertwig and Childs, that senility is due to an accumulation of inert catabolic products, is open to the least objection. A suggestion is offered that a more fundamental cause of senility than this may be found in the colloidal constitution of protoplasm with its units in the form of molecular complexes. The tendency, exhibited by certain non-living colloids, of a progressive change toward closer approximation of the molecules constituting the unit, for example, if also occurring in protoplasm would bring about changes in water content, permeability and in other characters which in turn might produce the accumulation of inert or toxic catabolic products.

The Mutual Relations of Host and Parasite in the Genus Gymnosporangium: B. O. Dodge.

It has been previously shown that the leaf form of *Gymnosporangium* on *Chamæcyparis* will infect *Aronia* and *Amelanchier*, giving two different types of æcidia. The galls produced on these hosts are also characteristically different. Later experiments show that different species of *Amelanchier* when infected with the stem form, *Gymnosporangium biseptatum*, develop different types of galls. Variation in the dimensions of the æcidia are also quite marked. This is in line with the results obtained by Long in connection with his experiments with *Puccinia ellisiana* and *P. andropogonis*, and Pammel's observations on the variation in the form of the peridial cells, etc., of *Gymnosporangium macropus* found on different hosts.

What are Chondriosomes? D. M. Mottier.

Argument.—If meristematic tissues of various plants are fixed in a certain mixture of chromosmic acid and sections made therefrom are stained with iron-hematoxylin or crystal violet (Benda's formula), there will be revealed in the majority of cells, in addition to the well-known and familiar cell contents, many small granules, chains of granules or rods of uniform structure but of variable size, that stain blue with crystal violet or black with the iron-hematoxylin. These have been described by various observers as chondriosomes. In the roots of higher plants many of these chondriosomes become leucoplasts, while in the stem they may develop into chloroplasts. Chondriosomes of this nature have been reported from a wide range of families among both higher and lower plants by Guilliermond and others. Different functions have been attributed to these bodies in different plants and in different parts of the same plant. The writer is in harmony with the view that certain so-called chondriosomes become leucoplasts in the root and chloroplasts in the stem. It is argued that in the cells of certain plants examined there are present in addition to these plastids other bodies similar in structure and in reaction to fixing fluids and stains, to the above-mentioned plastids, which do not develop into either leucoplasts or chloroplasts. These bodies are always present in some form (granules or delicate rods) in all cells, reaching a greater development in some cells than in others. They are permanent organs which should be given morphological rank with the nucleus and with the primordia of chloroplasts and leucoplasts. No homology is claimed between the bodies here under consideration and the chondriosomes of animal cells. It is suggested that in function these bodies may be concerned in various ways with the metabolism of the cell, and that, if the cytoplasm is con-

cerned directly with the transmission of hereditary characters, these bodies are to be looked upon as representing hereditary substance. They do not arise from the nucleus. Whether the term chondriosomes should be applied to the organs in question is left an open question.

The Nature of the Cell Plate: C. H. FARR. (Introduced by R. A. HARPER.)

A study of quadripartition of the pollen-mother-cells of a number of dicotyledons, especially *Nicotiana*, in which the cell-division appears to be accomplished without the organization of a cell-plate, but by furrowing as in the division of animal cells. The conditions under which the cells exist were found to approach more closely to those of the typical animal egg than the typical plant cell, namely: the absence of rectilinear cellulose cell-walls; the presence of a mucilaginous matrix, formed by the gelatinization of the walls; the loose disposition in the anther; the spherical form; etc. This suggests a physico-chemical interpretation of the cell-plate, that is, an accumulation of a salt in the equatorial plane between two nuclei. This salt remains in solution if the cell enlarges in response to the osmotic pressure generated by the salt. If, however, the cell can not enlarge either the salt is precipitated or attains such a concentration that the colloids about it are coagulated, thus forming the cell-plate. This conclusion is supported, not only by the present investigation, but by the absence or obscurity of the cell-plate in the algæ and fungi, and by the presence of equatorial structures in many encysted and incrusted animal cells.

The Life-History of Thraustotheca, a Peculiar Water Mold: W. H. WESTON.

In a study of *Thraustotheca clavata* (DeBary) Humphrey, an unusual form hitherto recorded only three times, twice from Germany and once from America, the following facts were ascertained: (1) The process of sporangiospore formation conforms to the usual saprolegniaceous type. (2) The genus is, however, unique among the Saprolegniaceæ in that dehiscence of the sporangium is effected through rupture of the wall as a result of swelling of the non-motile sporangiospores within. The fragility of the sporangium wall, moreover, has been greatly over-emphasized. (3) In their further development the sporangiospores may give rise to zoospores, germ tubes or dwarf sporangia. (4) The zoospores are grooved, laterally bi-ciliate, and of a characteristic shape that can not adequately be described by the terms "reniform" or "bean-shaped" that are generally used in this connection. (5) Gemmæ are formed, but represent merely a transient resting-state induced by unfavorable environmental conditions. (6) In the development of the sexual structures certain phenomena seem to justify the assumption that the formation of antheridia is dependent on contact of the antheridial filaments with the oogonia; and that oospore formation is, under normal circumstances, definitely correlated with the presence of antheridia on the oogonia. (7) In germination the oospores send out hyphæ which either, after limited growth, form sporangia or give rise to extensive mycelia, the type of development depending on the amount of nutriment present. (8) In its structure and development the fungus shows a resemblance to *Achyla* that, in the opinion of the writer, is sufficient to entitle it to a systematic position near the latter genus rather than near *Dictyuchus*.

The Embryogeny of Stangeria: CHARLES J. CHAMBERLAIN.

More than one sperm frequently passes through the neck of the archegonium, but it is extremely rare for more than one to enter the egg. In the metaphase of the first division of the fusion nucleus, only twelve (12) chromosomes, the haploid number, appear; but later divisions show twenty-four (24), the diploid number. Doubtless, the anaphase would show twenty-four (24), as will be described by Hutchinson in a forthcoming paper on *Abies*.

In the earlier free nuclear divisions there is usually a definite polarity, most of the nuclei being in the upper and lower thirds of the proembryo, while the middle third may have no nuclei at all. Toward the close of the free nuclear period all the nuclei in the upper part of the proembryo sometimes divide simultaneously, while those in the lower part remain in the resting condition, so that the nuclei in the upper part become smaller and more numerous than in the lower part. Later, some of the upper nuclei pass to the bottom of the proembryo and, with those already there, divide simultaneously, while those above remain in the resting condition. The embryo is formed from these lower nuclei. During the earlier extra-oval stages, haustorial activity is very prominent.

The Embryo-sac and Embryo of Thismia Americana: NORMA E. PFEIFFER.

Study of this Chicago representative of the Burmanniaceæ shows it to differ from some others of the non-chlorophyllous forms in that the megaspore mother-cell undergoes a reduction division,

giving rise to a row of three cells, the innermost of which functions. A normal eight-celled embryo-sac is found. The pollen has been found to germinate in nature, and probably fertilization occurs, a process not taking place in those forms where there is no reduction. Division of the fertilized egg is preceded by division of the endosperm nucleus. The oldest material available shows an embryo of eight cells, imbedded in conspicuous endosperm cells. The seed shows also the oddly differentiated cells at the chalazal end, as noted by other workers.

The Prothallia of the Cyatheaceæ: Alma G. Stokey.

This is a study of fourteen species taken from five of the seven genera of the Cyatheaceæ as given by Engler and Prantl. It includes the supposedly primitive form *Alsophila quadripinnata* C. Chr., also called *Lophosoria pruinata* Pr.

In general appearance the prothallia are of the polypodiaceous type, but in the division Cyatheæ most of the forms have multicellular hairs on both surfaces of the thallus in the anterior region. These hairs are found only on prothallia which have produced archegonia, never on the male prothallia. *Lophosoria* and the five species of the *Dicksoniæ* which were examined do not have multicellular hairs. The antheridia have a basal cell which is usually wedge-shaped; two ring cells, each of which is connected with the outer wall of the antheridium by a lengthwise wall; and two opercular cells, the smaller of which lifts like a valve. The walls, notably those of the stalk and lid cells, are often cutinized. The archegonia are more like those of *Osmunda* than those of *Pteris* and *Adiantum*. They have one or two basal cells; the walls of the neck cells are thickened and are often cutinized; the necks are usually straight. In young archegonia the neck cells have coarsely granular contents, but the neck cells of older archegonia contain a deeply staining mucilage differing somewhat from that produced by the breaking down of the canal cells.

Rapid Methods for Quantitative and Qualitative Studies on the Soil Flora: Thomas F. Manns.

The writer since 1901 has spent much time in the study of soil flora. The greatest difficulties encountered have been methods, apparatus and media that would expedite the work. After much experimental work the writer finds the mechanical shaker (run by electric motor) which accommodates sixteen bottles as used for soil analysis, is satisfactory for the preliminary work in properly mixing the sample. With the sixteen containers one may work with the surface samples from sixteen different soils at one time, or he may work with eight samples, including a study of the surface and subsoils. The time required for the plating of 16 soils in duplicate plates with two dilutions on four different media (equivalent to 256 plates) will be from two and one half to three hours. The dilutions will vary according to the groups from 1/1,000 of a gram, to 1/10,000 and 1/100,000 of a gram. The moist sample is prepared very fine and one gram is placed in the eight-ounce bottle (nursing) containing 50 c.c. or 100 c.c. of sterile water. The sample is shaken fifteen minutes. Other dilutions are made from this source.

Usually three media will suffice to bring out the important bacterial groups.

Medium I., for ammonifiers, saprophytic forms including molds, Actinomycetes, etc.

Medium II., for *B. radicicola.*

Medium III., for *Azotobacter, B. radiobacter* and nitrifiers. By means of a constant temperature apparatus, 32 tubes of each of three kinds of media may be kept melted at 43° C. ready for plating. Labelling plates consists in writing soil number, medium number and dilution. For the latter $A = 1/1{,}000$, $B = 1/10{,}000$ and $C = 1/100{,}000$ gram moist soil.

Media for Quantitative and Qualitative Studies on Azotobacter and Nitrifiers (illustrated by cultures): Thomas F. Manns.

Several workers, including Winogradsky, Beijerinck, Omelianski, Makrinoff and Löhnis have pointed out the difficulties in culturing nitrogen-fixing and nitrifying bacteria. The same workers and others have shown the importance of certain salts, including the carbonates of magnesium and calcium, also the value of phosphates, certain sugars, soil extracts or humus. Several have shown intimate symbiosis between certain nitrogen-fixing forms such as *B. radiobacter* and *Azotobacter chroococcum.* Löhnis in his "Laboratory Methods in Agricultural Bacteriology," p. 97, has shown the stimulating action of magnesium carbonate and calcium carbonate on the nitrifying bacteria. He states in the same work that "Many different methods have already been tried, but the obtaining of pure cultures of the nitrifying organisms is still a most difficult bacteriological problem. The method which is most to be recommended is the gypsum-magnesium-plating method, proposed by Omelianski and Makrinoff." In reference to *Azo-*

tobacter, he says: "On standard media, it grows only moderately, but, on the contrary, very well on gypsum plates which have been wetted with mannite solution." The writer in making a quantitative survey of the bacteria in various groups of soil organisms, found it necessary to modify and invent new media for the *Azotobacters* and nitrifying organisms; after considerable experimental work it was found that the ingredients of a good *radicicola* or *Azotobacter* medium in a soil extract agar, to which, after tubing was added, about .5 gram of a mixture of insoluble salts, including the carbonates of calcium and magnesium, with kaolin, would bring out the nitrogen-fixing organisms (*Azotobacters, B. radicicola, B. radiobacter*) and the nitrifying organisms (*Nitrosomonas* and *Nitrobacter*). Some of the standard media worked fairly well when balanced by the insoluble minerals. By use of qualitative chemicals the active nitrifying colonies could be easily demonstrated on the plate. These media differ from others in that the insoluble minerals in the tube are shaken up at the time of inoculating and poured into the Petri dish. The studies again emphasize the importance of basic compounds, humus and symbiosis in bringing out *Azotobacter.* The western soils (Colorado, North Dakota) show many *Azotobacter chroococcum.*

Peat Organisms that Slowly Liquefy Agar (illustrated by culture): THOMAS F. MANNS.

While making a study of the flora of raw peat and muck, the writer observed that certain colonies of *bacteria* were able to completely break down the agar and cause deep pitting in the medium. The writer has never met with similar organisms in his extensive culture work on agricultural soils. They are probably quite closely confined to peat and moor soils. Erwin F. Smith mentions in Volume I., "Bacteria in Relation to Plant Disease," p. 32, that "Metcalf has described a bacillus which slowly softens it (agar), and the writer has observed similar phenomena." The organism, which appears to be a micrococcus of about one micron in diameter, was found most abundant in peat that was composted with floats (*ground calcium phosphate*) and *calcium carbonate,* 200 lbs. of each to a ton of the former. The writer has made no extensive morphological, physiological or cultural studies upon the organisms. Note of its occurrence is made here solely from the interest that enzymes of such active properties are produced by bacteria. This agar-digesting organism was grown on the following medium:

	Grams
Mono-potassium-phosphate ($K H_2 PO_4$)...	4.00
Wood ashes (chestnut)	12.00
Ferric sulphate	.25
Mannite	10.00
Agar	12.00
Water 1,000.00	

Some Observations on the Occurrence of Sterile Spikelets in Wheat: A. E. GRANTHAM.

The examination of a large number of varieties of wheat grown at the Delaware Agricultural Experiment Station during 1915 indicates that there is considerable variation in the percentage of sterile spikelets per spike among the leading varieties of winter wheat. The study included observations on wheat sown under ordinary field conditions and by the centgener method. It was noted that the varieties grown under field conditions exhibited a higher percentage of sterile spikelets than where the plants were grown 6 inches apart each way as under the centgener method of planting. That is, the thickness of planting appeared to be a factor directly related to the frequency of sterile spikelets. The number of sterile spikelets per spike (the average of 25 spikes for each variety) and the percentage to the whole number of spikelets were determined for 188 varieties of wheat. Of these varieties 80 were beardless and 108 were bearded. The average percentage of sterile spikelets in the bearded varieties was found to be 25.1 per cent., while the beardless averaged 17.8 per cent. This indicates that the bearded varieties, as a class, have a higher percentage of sterile spikelets than the beardless wheats. Only 20 of the 80 varieties of beardless wheats had more than 15 per cent. of sterile spikelets, while not a single variety of bearded wheat had less than 17 per cent. sterile spikelets. Forty-five of the 108 bearded varieties had 25 per cent., or more, sterile spikelets. Of the 80 beardless varieties only 2 had 25 per cent. sterile spikelets. The occurrence of sterile spikelets was also noted on two varieties of wheat (one bearded and the other beardless), when planted at different dates. The two varieties were planted at seven-day intervals from September 17 to October 22, on fertilized and unfertilized soil. The wheat planted at the earlier dates, whether fertilized or not, had a higher percentage of sterile spikelets than the later seeding. In this case, also, the bearded variety had the higher per cent. of sterile spikelets. Two varieties of wheat fertilized with different combinations and quantities of plant food exhibited considerable variation in the number of sterile spikelets. Phosphoric acid and potash used

singly developed a higher per cent. of sterile spikelets than nitrogen, where two of the plant food elements were used in combination. Nitrogen and potash showed the smallest per cent. of sterile spikelets, while phosphoric acid and potash gave the highest. The untreated plots showed a very low per cent. of sterile spikelets, as compared with those receiving complete fertilizers. Correlation studies between the total number of spikelets per spike and the number of sterile spikelets per spike indicate the longer the spike or the more spikelets it carries, the greater the number of sterile spikelets.

Inbreeding in Maize: Donald F. Jones.

Twelve generations of continuous inbreeding in maize confirm previous conclusions. The reduction in vegetative vigor is rapid at first, but gradually slows down and finally ceases. This reduction in heterosis is correlated with the theoretical approach to complete homozygosity. There is a marked tendency towards complete uniformity within the limits of physiological fluctuation. Accompanying the reduction in variability there is a segregation of characters and an isolation of subvarieties, some having abnormalities. These subvarieties differ in their power for development as expressed by size of plant and yield of grain. After continued inbreeding there is an approach to the stability of a naturally inbred race. The constantly segregating characters in the original cross-bred race are of little value in classification.

The Chlorophyll-factors in Lychnis dioica: George Harrison Shull.

Three Mendelian factors are responsible for the chlorophyll of the normal dark green biotypes of *Lychnis dioica*. One of these factors, *Z*, differentiates all green strains from albinos, capable only of ephemeral existence. A second factor, *N*, acting with *Z*, produces a form with approximately two thirds as much chlorophyll as the normal. The third factor, *Y*, acts in conjunction with *Z* and *N*, to produce the full green color. In the absence of *N*, *Y* produces no noticeable effect, for plants with the constitution *XXZZnnYY* have not been successfully distinguished from those having the formula *XXZZnnyy*, though plants having these two formulæ have now been separated by cultural methods.

Experiments in Recombining Endosperm Colors in Corn: R. A. Harper.

My work in crossing corns with different colored endosperms has given me results perhaps best described in general as the so-called "breaking up" of characters as understood by the older plant breeders. Well-established and constant black races crossed with white races have given both in the F_1 and the F_2 generations, series of colors including dark purples, reds, blues, grays, etc., in very many shades. Some of these color types are fairly constant, others fluctuate when selfed. During the past summer a series of recombination tests were made to determine whether the ancestral black could be regained by recombining various pairs of these extracted color forms. The results show a further wide range of variation. The largest per cent. of dark kernels was given by a deep olive-gray pollinated by a dark vinaceous purple, but equally dark individual kernels were given by a pale gray or even by white pollinated by the same red. Deep olive-gray pollinated by dark violet gave quite uniform slate grays and grayish blues with tinges of purple. No immediate and uniform return to the ancestral black is obtained by such recombinations so far as yet tested.

Evidences of Hybridism in the Genus Rubus: C. S. Hoar. (Introduced by E. C. Jeffrey.)

The genus *Rubus* in common with other genera of the Rosaceæ has presented a very difficult problem to the systematic botanist. The species described in certain regions, where the genus has been most carefully studied, mount sometimes into the thousands and are often distinguished with the greatest difficulty on account of intergrading forms. Many systematic botanists have consequently been led to the opinion that in this genus hybridism is extremely common under the conditions found in nature. The present communication is for the purpose of making clear that the morphological data are strongly in favor of widespread hybridism in the genus *Rubus*. It has long been recognized that two prominent and often correlated features of hybridism are extreme variability of species and sterility of the reproductive cells (particularly the pollen). A high degree of imperfection is frequently characteristic of the microspores of *Rubus*, especially in those species which overlap in their geographic range and flowering periods. This condition is well illustrated by the highly variable species *Rubus villosus* and *Rubus strigosus* (the probable parent of the Cuthbert raspberry). On the other hand, in *Rubus odoratus*, a species of a high degree of constancy, which flowers long after the mass of *Rubus* species have cast their blossoms, the pollen presents a high condition of perfection. Similar conditions are presented by the interesting species *R. deliciosus*, limited geographically to the Rocky Moun-

tains. In general there is good evidence from the standpoints of extreme variability and correlated gametic sterility of the widespread occurrence of natural hybridism in the genus *Rubus*. The genus accordingly affords one more argument in favor of the view now rapidly gaining ground, that hybridism is at once a prominent cause of variability and the appearance of new species in the Angiosperms.

Pollen Sterility in Relation to the Geographical Distribution of Some Onagraceæ: CARL C. FORSAITH. (Presented by E. C. JEFFREY.)

The genus *Œnothera* has been mentioned frequently in communications concerning mutation and hybridization. It seems fitting, therefore, that other genera of the Onagraceæ should be examined for evidences of inter-species crossing. The well-established correlation of pollen sterility and hybridization is considered as a determining factor in this connection. Studies of the *Chamaenerion* subgenus of *Epilobium* presents interesting results. Anthers chosen from the more southern representatives of *Epilobium angustifolium* L. show uniformly potent microspores. Selections of material from stations where this plant is coexistent with its ally, *E. latifolium* L., disclose often abundant abortive pollen grains. The more uniformly distributed group belonging to subgenus Lysimachion, reveals impotent microspores quite generally. The monotypic *Zauschneria californica* Presl. and the geographically limited *Epilobium angustifolium* are seen to present unimpaired fertility. *E. angustifolium*, however, occurring within the territorial limits of *E. latifolium* in North America, manifests microscopic proof of previous cross-fertilization. This feature is in marked contrast to the more uniformly perfect pollen development habitually present in the geographically limited species just mentioned. Thus it is apparent, from the morphological standpoint, that interspecies crossing is a not uncommon occurrence among the Onagraceæ where such is not prevented by kinship or distribution. This interesting fact was first noted by Miss Ruth Holden, of Cambridge, England.

Seed Sterility and Delayed Germination in Œnothera: B. M. DAVIS.

A study of fifty species, races and hybrids of *Œnothera*, have given surprising data on the extent of seed sterility and delayed germination within this group. The importance of recognizing in genetical work the problems presented by this situation will be discussed and illustrated. A method will be outlined whereby it is hoped that complete germination of seeds may be rapidly forced to completion and at the same time may permit of the preservation for examination of the residue of sterile seed-like structures.

The Production of 14(+)-Chromosome Mutants by 14-Chromosome Œnothera Lamarckiana: ANNE M. LUTZ.

Gates and Thomas have counted 15 chromosomes in 21 plants variously classified as *Œnothera* mut. *lata*, *O.* mut. *semilata*, *O. lata* to *semilata*, *O.* mut. *lata rubricalyx*, *O. biennis* mut. *lata* and as *lata*-like forms. Gates had mentioned these results in an earlier paper in 1913 referring to *O.* mut. *lata rubricalyx*, which was found among the F_2 offspring of a cross between two 14-chromosome forms, he says: "The possession of fifteen chromosomes by this plant also shows that whenever a meiotic irregularity leads to the formation of an individual having an extra chromosome, such a plant will have the leaves and habit of *lata* or *semilata*." Although he adds in a footnote that "it is possible that one or two other mutants also have an extra chromosome," he does not state that such forms are not *lata*-like; furthermore, Gates and Thomas say later "Certain other mutants indicate by their hereditary behavior that they may also have aberrant chromosome numbers, but this has not yet been proved, except in *gigas*." All of the arguments offered by Gates and Thomas point to the conclusion that whenever a meiotic irregularity in a 14-chromosome form leads to the production of an 8-chromosome gamete, if the latter is capable of functioning, the union of this cell with a 7-chromosome cell will produce *O. lata*, *O. semilata*, or some *lata*-like form. While many 15-chromosome forms have *lata* or *lata*-like characters, many 15-chromosome mutants, offspring of 14-chromosome forms, are quite unlike *O. lata*. I have counted 15 chromosomes in 11 distinct mutant types: (1) *O. lata*, (2) *O. albida*, (3) *O. bipartita*, (4) type 5,509, supposed to be a modified form of de Vries's *oblonga*, (5) *O. nanella lata*, (6) *O. subovata*, (7) type 2,256, (8) type 4,499, (9) *O. exilis*, (10) *O. exundans*, (11) type 5,365. The first six are produced by *O. Lamarckiana* and other forms—the first four being very common types. Type 2,256 is produced by 14-chromosome *O. nanella*, selfed, type 4,499 by *O. lata*, selfed, and by *O. lata* × *O. Lamarckiana*, while the three remaining mutant types have been observed in cultures of selfed *lata* only, thus far. In addition to the foregoing,

15 chromosomes were counted in a form produced by *Lamarckiana*, bearing a number of characters in common with type 5,509. Fifteen (?) chromosomes were counted in *O. elliptica* (*Lamarckiana* mutant)—number not determined precisely—and in an unnamed mutant from one of de Vries's 1912 cultures of *O. lata* × *O. Lamarckiana*, said to combine the characters of *O. lata* with the smooth, shiny leaves of *O. laeta*. Only 2 of the 11 distinct types in which 15 chromosomes were counted precisely by the writer had *lata* or *lata*-like characters; namely, *O. lata* and *O. nanella lata*. Many other named and unnamed mutant offspring of *O. Lamarckiana* and other 14-chromosome types which can not be designated as *lata*-like forms, indicate by the nature of their somatic characters or hereditary behavior, or both, that they have 15 chromosomes; for example, *O. scintillans*, *O. sublinearis*, *O. leptocarpa*, etc.—mutant offspring of *O. Lamarckiana;* and *O. nanella oblonga*, *O. nanella elliptica*, etc., produced by *O. nanella*. While it is possible that 9- and 6-chromosome gametes, capable of functioning, may be produced by 14-chromosome forms occasionally, that a 9- might unite with a 6-, in rare instances, and produce one of the uncommon types of 15-chromosome mutants, it is probable that most 15-chromosome offspring of 14-chromosome forms, particularly the common types—whether *lata*-like or not—result from 8-7 unions. Of particular interest, in connection with this discussion, is the fact that a *lata*-like mutant appeared in a 1908, and another in a 1910, culture of *Lamarckiana* pollinated by *Lamarckiana*. The two did not duplicate each other nor *O. lata*, and each had 16 instead of 15 chromosomes. They may have arisen from 8-8 or 9-7 unions.

A Comparison of the Wood Structure of Œnothera stenomeres and Its Tetraploid Mutation gigas: W. W. Tupper and H. H. Bartlett.

The change from the $2x$ to $4x$ chromosome number in *O. stenomeres* is concomitant with (1) An increase of 50 per cent. in the length of the vessels, and of 150 per cent. in the area of the cross-section. (2) An increase of 50 per cent. in the length and diameter of the tracheids, corresponding to an increase in volume of 200 per cent. (3) An increase in all three dimensions of the ray cells, but not a proportional increase, resulting in a cell of a different shape with an increase of 275 per cent. in volume. (4) A breaking up of the tall multiple medullary rays into their constituent simple rays.

Orthogenetic Saltation in Nephrolepsis: R. C. Benedict.

The title, "Orthogenetic Saltations in *Nephrolepsis*," was selected to emphasize two points: First, the variations to be described are discontinuous and of considerable magnitude, *i. e.*, "jumps" or saltations; second, these variations are definitely directed (orthogenetic) along a few distinctly limited lines. The present consideration is purely descriptive. The variations dealt with are all from one variety, *bostoniensis*, of the species, *N. exaltata*. From this variety have come at least three distinct lines of variation, viz., progressive dwarfing, progressive increase in division of leaf, and progressive increase in waviness of leaf. The illustrations to be given are as follows:

Progressive dwarfing: (1) *bostoniensis—Scotti—Wagneri*. (2) *Rooseveltí*—Teddy, Jr.,—new form as yet unnamed.

Progressive increase in division of leaf: (1) *bostoniensis—Piersoni—Barrowsi—Whitmani—magnifica*. (2) *Scotti—Scholzeli* (2-pinnate)—*Scholzeli* (3-pinnate).

Progressive increase in waviness of leaf: (1) *exaltata—bostoniensis—Harrisi*—Wm. K. Harris.

Another type of variation, not progressive but retrogressive, is shown in the reversion forms which, however, can not be mentioned in detail here. Finally, two points are to be emphasized. There are at least sixty different sports of *bostoniensis*, nearly all of which may be placed in one of the series mentioned above. These variations are all vegetatively produced.

An Interesting Modification in Xanthium: Charles A. Shull.

A peculiar modification of the burs of *Xanthium* is described, in which the number of the flowers surrounded by the involucre has been greatly increased. In one specimen, a cross section of the bur showed the presence of twenty-six involucral cavities. Twenty-three of the cavities contained the remains of ovarial walls, twelve of which had normally developed seeds, and eleven of which had aborted. Three cavities showed no indications of ovaries, but their position is evidence of their nature. The manner in which this form originated is unknown, but it seems probable that it is either a mutation or a reversion from *X. canadense*. Unfortunately this interesting variety was extinct, so far as the local appearance is concerned, at the time it was received.

H. H. Bartlett,
Secretary

(*To be continued*)

SCIENCE

FRIDAY, MARCH 3, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

GENERAL PROBLEMS AND TENDENCIES IN CANCER RESEARCH[1]

AFTER the successful continuous transplantation of rat sarcoma and mouse carcinoma had shown that we possessed a method suitable for the study of the biology of tumors, and which promised a rich harvest of results, the decade following the year 1901 was to a great extent devoted to the study of propagated tumors rather than to the analysis of the first origin of tumors, although this latter problem had never been entirely neglected. Within recent years, however, much attention has been given to the origin of tumors. The so-called endemic occurrence of cancer which we observed in the case of cattle and rats, and which certain investigators noted in the case of mice and other animals, suggested to us sixteen years ago the possible significance of heredity as an etiological factor. Some years later, observations which we made in a mouse-breeding establishment in Granby confirmed this hypothesis; but it is only during the last six years, following the observations of Tyzzer and Murray, that our investigations, carried out in conjunction with Miss Lathrop, proved on a very broad basis the very great significance of heredity in the transmission of cancer in mice, the partial independence of the age and frequency factors, and the correlation between cancer frequency and structural and functional characteristics of the animal. The results of hybridization experiments which we carried out on a large scale indicate that in some crosses the tendency to a high

[1] An address before Section VIII. of the II. Pan-American Scientific Congress on January 5, 1916.

cancer rate may be dominant, while in some others the opposite tendency predominates, and in a few an intermediate result is obtained. Our experiments established for the first time the cancer rate for a number of different strains; each strain was followed through several successive generations and in each generation a large number of animals were observed. The resultant figures for the various generations of the same strain were usually in fairly close agreement. Animals belonging to such strains were used for hybridization experiments. The results of hybridization experiments which we obtained do not seem to be compatible with the view recently expressed that the tendency to cancer is a recessive character and that all results can be explained on such a basis.[2]

Of a different character is a problem in heredity first studied by E. E. Tyzzer. It is well known that some strains of mice are a favorable soil for a certain transplantable tumor, while other strains are not. In crossing a favorable and an unfavorable strain Tyzzer found conditions apparently incompatible with Mendelian principles. We obtained likewise in subsequent experiments with M. S. Fleisher, results similar to those of Tyzzer, and we suggested that the results might be explained by assuming the presence of multiple factors. The same interpretation may apply to the heredity of autochthonous tumors to which we referred above and in which also simple Mendelian proportions do not seem to exist.

These studies of the cancer incidence in various strains of mice and the methods used therein have, however, a much wider significance. On the basis of a thorough knowledge of the cancer incidence in certain families, and on this basis alone, will it be possible to analyze certain other factors in the etiology of tumors, and the understanding of these latter factors, as well as of heredity, will perhaps ultimately provide us with a rational basis for the prevention of cancer. Without a thorough knowledge of heredity, conclusive results as to the significance of other factors could not be expected. Acting on this principle, we found that castration in sexually mature mice at the age of three to eight months reduces the cancer rate in a very pronounced way. Prevention of pregnancy, while it still has some effect in reducing the cancer rate, as we found several years ago, has very much less significance than castration.

These results and some additional ones to be mentioned shortly permit us to classify the causes of tumors into two main divisions, internal and external ones. Heredity belongs to the former class. The point of attack of these hereditary factors we do not yet know. In some cases, they may perhaps stand in relation to some other internal factors, which are in all probability of significance in certain cases. I refer to the spontaneous parthenogenetic development of the egg within the ovary and elsewhere in mammals, a process which, according to our findings in the guinea pig, is not a rare occurrence, and may even normally proceed to the formation of the anlage of the central nervous system. To this class of factors may also belong developmental errors which were already suspected by Cohnheim and which as we know may appear as inheritable mutations in various groups of animals.

The external factors may be further divided into chemical and mechanical, and both may be derived either from within the body or from the outside world. As an example of a chemical factor originating within the body, we may cite the great importance of the internal secretion of the

[2] Maud Slye, *Interstate Medical Journal*, XXII., July, 1915, p. 692.

corpus luteum in the origin of cancer in mice to which we referred above, but other internal secretions will probably be found to be of similar significance. External mechanical factors can be recognized in the well-known effect of chronic irritation. How far certain parasites, especially those in the class of vermes and insects, produce cancer through chemical and how far through mechanical means is not certain. Previous observations in man in the case of cancer of the bladder caused, directly or indirectly, by bilharzia, and especially the recent experiments of Fibiger make it, however, quite certain that such parasites may be the cause of cancer. It is likewise uncertain how far Roentgen-ray cancer, frequent in Roentgen-ray operators, and also apparently experimentally produced in a few rats by Marie, is due to ulceration subsequent to exposure to or to the direct stimulating action of the rays. In some cases perhaps chemical and mechanical factors may cooperate in producing tumors; the efficiency of such a combination in calling forth tumor-like formations has been shown by us in the case of deciduomata of the uterus, which we produced experimentally, a new formation which we included in a class designated as transitory tumors.

There are observations on hand which indicate that growth stimuli may be especially active in animals with a hereditarily determined tendency to cancer. Such an observation we made in the case of a cancer in a mouse belonging to a family rich in tumors, where ulceration of the skin near an adenoma of the mammary gland led to the development of an epidermal carcinoma. Further systematically conducted experiments in this direction might lead to interesting results.

It is, however, not probable that in order to obtain the production of cancer there must be a definite quantity of prerequisite internal factors. On the contrary, there is some evidence on hand which makes it probable that internal and external factors may vary in inverse ratio, and that if the external factors are quantitatively very strong, the quantity of internal factors may be reduced.

If we survey briefly the various types of growth reactions known in vertebrates, we may perhaps, according to the character of the stimuli, which are usually in each case the first members in a complicated reaction chain, and according to the character of the systems on which they act, provisionally distinguish the following types:

1. Various stimuli act for a short time on complex systems, the egg-cells, and lead to a long chain of growth phenomena which ultimately cease. The experiments in artificial parthenogenesis of Jacques Loeb led to a very far-going analysis of these phenomena.

2. Defects lead to a chain of growth phenomena, which are of a temporary character, and which come to a standstill after a certain quantity and kind of new-formed tissue has more or less completely filled out the defect.

3. Chemical substances stimulate the growth of certain tissues to which they bear a more or less specific relation. These growth phenomena come to a standstill with the activity of the stimulating substance or very soon afterwards (corpus luteum and mammary gland).

4. A combination of factors 2 and 3 may lead to tumor-like growth phenomena when either factor alone would cause only a slight proliferation. Here again the effect is temporary (experimental deciduomata of the uterus).

5. Chemical (fat soluble?) bodies which do not show a specific relation to the organs affected stimulate various tissues to a temporary proliferation; fat soluble stains

(Bernhard Fischer and others) and ether (Reinke) are substances that under certain conditions seem to exert a stimulating effect.

6. Chemical and mechanical factors produce with the aid of a large quantity of internal factors, or in certain cases apparently without such aid, an increase in cell proliferation that persists after the stimuli have ceased, which is permanent, potentially of unlimited duration in contradistinction to the temporary reactions mentioned above. This is the cancerous reaction with which all or at least the large majority of the mammalian tissues may respond. Neither potential immortality—some, or perhaps all, somatic cells are potentially immortal—nor the power of continued proliferation, which in all probability even certain ordinary somatic cells possess, is characteristic of this reaction, but rather the increase in proliferative power, and furthermore the permanency of the reaction in response to a temporary, non-permanent stimulus. We have then to assume that a labile cell-system which responds to temporary stimuli with a temporary reaction is transformed under the influence of certain stimuli, and often with the aid of hereditary factors, into a stable system which shows a greater proliferative power than the labile system. The stimulus thus brings about merely a transformation of the cells into a new kind of cell-system, which proliferates indefinitely at a more or less increased rate. Such a transformation may be called a mutation.[3] Inasmuch as all, or the large majority of all body cells are liable to this change, they must have from the beginning in their organization a mechanism that provides for the possibility of such a mutation.

[3] We would have to deal in this case with a mutation, not in a germ cell, but in a somatic cell. For a more detailed discussion of this problem *cf.* Leo Loeb, "Germ Cells and Somatic Cells," *American Naturalist*, Vol. 49, 1915, p. 286.

According to this conception, we must then assume that all or most cells have potentially two equilibria, the normal one and the cancerous; they begin life with the normal equilibrium, but under the influence of certain stimuli, with or without the cooperation of hereditary factors, they are transferred to the cancerous equilibrium.

Cells in the normal equilibrium react to stimuli in the manner indicated above (types 1 to 5); ultimately they return invariably to the normal equilibrium after the stimulus has ceased to act. Cancerous cells, on the other hand, may perhaps be exterminated, but they are not known to return to the normal equilibrium.

There is, however, an alternative to this conception which would eliminate the necessity for assuming a new equilibrium for cancerous proliferation, an assumption for which naturally no analogy can exist. If we assume that an external agent associated with the cell, rather than a physico-chemical mechanism within the cell, produces the cancerous proliferation, the latter would no longer represent a unique condition, but would be a special application of one of the types 3 to 5, in which, however, the stimulus would act incessantly. Such a stimulus could be supplied through multiplying microorganisms which essentially represent constantly newly formed external chemical stimuli. Such microorganisms would not be identical with bacteria causing various ordinary infectious diseases. As we have shown at an early stage of our investigations, cancer among animals is not infectious in the sense in which certain other diseases are infectious. We could feed tumor tissue to normal animals or keep normal animals in the same cage with cancerous animals without a transfer of the disease taking place; neither could Ehrlich produce cancer in young mice which were suckled by cancerous animals. But this does not

exclude the possibility that certain other organisms might play a certain rôle. We know that microorganisms can call forth cell multiplication in plants and animals. In plants, certain bacteria can produce, as has especially been demonstrated in the case of the crowngall by Erwin F. Smith, tumor like proliferation—a result depending in this case not merely on the kind of stimulus, but also on the particular system on which the stimulus acts. In this connection we might also mention a number of extremely interesting cases in which various investigators saw the transformation of normal into cancerous tissues, subsequent to contact with cancerous tissue of another kind, but in the same individual. I referred above to an observation of this character in which we found skin to become cancerous under the influence of an adenocarcinoma of the mammary gland. Similarly, in contact with carcinoma, connective tissue may become sarcomatous. Such tumors we called combination contact tumors. In such a carcinosarcoma in a Japanese mouse which we studied experimentally, we found that the carcinomatous and sarcomatous components followed the same variation curve of growth energy in succeeding generations. This suggests the identity of the agent which causes the proliferation of both tissues and the dependence of the variation in growth upon the variation in the activity of the agent. The agent transferred from one tissue to another might be a chemical substance—an explanation first suggested in the case of the sarcomatous transformation of the stroma by Ehrlich and Apolant—or it might be a microorganism. Even under normal conditions there are indications which point to a chemical influence exerted by one tissue upon another. In this manner we interpreted the difference in cell activity in the connective tissue of the mucosa in certain organs near the epithelium on the one, and near the submucosa on the other hand. The different effect exerted by the tissues of different individuals upon the activity of the fibroblasts of the host also points to such a conclusion (different effects of auto- and homiotransplantation).

The very important results of Peyton Rous are worthy of especial consideration. This investigator, working with fowls and employing methods which in the case of mammalian tumor had not led to positive results in the hands of earlier investigators, was able to separate by filtration and other means the causative agent from the sarcoma cells with which it was associated. In this case, we might have to deal either with filterable microorganisms, or again with chemical substances. If we accept the latter alternative, we would have to assume that the same substance that initiated the cancerous cell proliferation in normal cells would, after the change has once been accomplished, be perpetually newly formed within the proliferating cells. This condition would in some respects be comparable to an autokatalytic process.[4] The cancerous equilibrium would represent a condition in which this growth substance is either produced in a larger quantity than it exists in normal cells, or is entirely formed de novo. It seems furthermore that no antibody is produced in the body-fluid against this substance. These substances do not seem to be separable from the cells in all fowl tumors, and the kind of fowl tumors in which a separation can not be accomplished behave in this respect like the mam-

[4] Certain analogies between growth curves and autokatalytic processes have formerly been pointed out by Jacques Loeb, W. O. Ostwald and T. B. Robertson. In the case of fowl tumors we would have in addition to deal with the new formation within the tissue cells of a substance carried to the tissues from the outside.

malian tumors. We would have to assume the existence of different substances of this kind, and different substances always call forth a specific activity of connective tissue cells resulting in the reproduction of the original kind of tumor, and stimulating endlessly the production of the same specific substance within the fibroblasts. Just as in the case of the corpus luteum substance which is responsible for the production of deciduomata, the cooperation of a mechanical factor seems to be essential for the stimulation of tumor growth in fowl. We would most probably have to give this interpretation to these phenomena if the observation of Casimir Funk, according to whom an alcoholic extract of the tumor contains the active agent, could be confirmed in a larger number of cases. If this should prove correct, we may expect to find corresponding conditions in mammalian cancer. A study of heredity in cancer of the fowl would close this chain of investigations, and with the analysis of internal and external factors in cancer already on a solid foundation, we could then conclude that the causes of cancer in their main outline have been satisfactorily analyzed. Of course underneath this first plane of causes there are connections which extend further into fields where they meet with other factors determining cell and tissue life in its dependence upon physical and chemical laws, and thus we are led into deeper planes of causation. But here the problems have become identical with those of general biology, the laws governing cell division and ameboid movements in cancer cells not differing from those of other cells.

In this connection a few words concerning the definition of cancer might not be out of place. It might indeed be assumed that a definition of cancer satisfying past and future research is one of the essential requirements for the fruitful pursuit of investigation. On the contrary, I believe that at the present stage of investigation progress may be retarded through premature rigidity in defining cancer, and especially through insisting on the proof that secondary tumors originate from transplanted cells. In the case of sarcoma of the rat and mouse, this proof has so far been supplied only in the rat sarcoma of the thyroid found in Chicago, and is merely based on analogy in the case of the large majority of other sarcomata. Since it has now been shown that in sarcoma of fowl an agent associated with the tumor, but separable from it, may just as well give origin to new growths, we may well hesitate in excluding from consideration new formations which in all probability under certain conditions have their origin in transplanted cells, while in other cases they may perhaps be propagated through an agent associated with the tumor. I refer here especially to the so-called lympho-sarcoma or small round cell sarcoma of dogs which, after transplantation in dogs, apparently grows from the transplanted cells (Sticker, Ewing and Beebe, and L. Loeb), while in the fox, according to von Dungern, the tumor cells are composed of host tissue. May we not, in case von Dungern's view should prove correct, have to consider the possibility that the transplanted dog cells perished in the foreign species, and that the associated agent stimulated the host cells to proliferation?

With the factors which we have already analyzed—factors of heredity, of internal secretion, of external, chemical and mechanical stimulation—we are in a position to control to a great extent the cancer rate in certain species of animals. As we said, we can not yet exclude with certainty the other alternative, namely, microorganisms, as an additional causative factor.

After so many futile attempts to establish a direct proof of their presence, further

efforts of this kind do not appear promising at present. There seem, however, still other ways open through which one may approach this problem in an indirect manner.

To decide between the two alternatives which we mentioned does not only concern cancer research in the more restricted sense, but is of the greatest importance for general biology. In return for much that it received from neighboring sciences, cancer research has given something important to biology; the serial endless experimental propagation of tumors has enriched biology with a valuable instrument of research and new outlooks on the life and character of somatic cells have been gained. We may briefly mention the following facts established or very strongly suggested: In the course of our early transplantations, we found that the energy of tumor growth can be experimentally increased as well as decreased. Ehrlich explained the increase as due to a selection of rapidly growing tumors; we, however, believed from the beginning that it was partly produced by a mechanical stimulation of the tumor cells and in addition was possibly due to chemical stimulation caused by the transfer into a new host with a different constitution of the body-fluids; in some cases perhaps processes of immunity may also enter into this phenomenon.

In conjunction with M. S. Fleisher, we noted that chemical bodies which inhibit tissue growth at a certain period in the life of tumors do not have this power at other periods. Especially are they powerless in the case of very young tumors, an observation confirmed by Keysser. But we found that such early injections produce an immunization against the later action of these substances. The proof thus given that an immunization takes place against substances (and apparently also against physical agencies) inhibiting tumor growth is, as we pointed out on previous occasions, of great importance in our attempts to arrive at a rational treatment of cancer. Our experiments suggest, furthermore, very strongly that this immunity is of a twofold character, that it originates in the host as well as in the tumor cells themselves; that this cell immunity can be transferred to a certain number of later cell generations and is to some extent specific for the substance which had called it forth. While our results, based on the observation of a very large number of animals, strongly suggest these latter conclusions, we nevertheless think it desirable to add new evidence in order to guard against a complication with variable factors.

Are we in all these cases dealing with indirect actions on the cells and with direct actions on accompanying microorganisms, or with direct actions on the cells? We rather incline to the latter view and we would suggest that an increase in chemical activity in the tumor cells—an increase perhaps restricted to certain activities—renders the latter a much finer balance in their response to certain environmental conditions through variations in growth energy than are the normal tissue cells.

As we pointed out in 1901 on the basis of Morau's and our own experiments, cancer cells are potentially immortal in the same sense in which Protozoa and germ cells are potentially immortal. All, or at least the large majority of all normal tissue cells are potentially cancer cells, and we may therefore with full justification conclude that ordinary somatic cells are likewise potentially immortal. Like the majority of tumors, they can not be indefinitely propagated in other individuals of the same species because of the injurious action of what we may term homoiotoxins. On the other hand, thanks to their increased growth energy and perhaps a lessened sensitiveness

to homoiotoxins, the cells of certain tumors can overcome the injurious conditions existing in other individuals of the same species and be propagated indefinitely. Tumor cells and ordinary tissue cells do not differ in potential immortality (as Bashford and others assumed), but in the intensity with which they proliferate and in their destructive power.

Of equally great biological interest are the defensive reactions called forth in the host through the growth of the tumor cells. As one of the most important results, we may here state that no immunity seems to be produced through tumor growth in the animals in which the tumor originated. We found that in the case of rat and dog tumors, cells remained alive and grew after transplantation into the animal in which they originated, while they died in other individuals of the same species. Tyzzer found the same to be true in the chicken, and Haaland and Fleisher and ourselves in the mouse. Haaland's experiments suggested, furthermore, that the autochthonous tumor could not act as antigen and by proving in addition that this tumor does not neutralize immune substances, our experiments prove the correctness of Haaland's suggestion that against an autochthonous tumor no immunity can be produced. The greater significance again attached to the study of animals in which tumors originated in contradistinction to bearers of experimental tumors, is one of the characteristic tendencies of recent cancer investigation, and it is of interest in this connection to note that our experiments indicate that animals with autochthonous tumors are a better soil for the growth of other spontaneous tumors than normal animals.

While therefore in the organism in which the tumor originated usually no reaction takes place against tumor cells, reactions do take place after transplantation of tumor cells into other individuals. These reactions are essentially of a similar character in the case of tumors and of normal tissues. Again correlation between the behavior of normal and of cancerous tissues has proven fruitful of results in this case. After autotransplantation of a piece of normal tissue, it may in the same way as a piece of tumor, at least in the case of certain tissues, apparently live indefinitely, while after homoiotransplantation, as we observed, the tissues die as a result of the attack by lymphocytes and through the influence of fibroblasts of the host which produce dense fibrous tissue which in turn strangulates the foreign cells. There is a possibility that the strange body fluids may also directly interfere with the metabolism of certain transplanted tissues to such an extent as to severely injure them. After heterotransplantation the indirect injurious action of the body fluids, which are unsuitable for the metabolism of the transplanted cells, is more pronounced and leads to the early death of the transplanted cells. We found in the case of skin under these conditions no noticeable activity on the part of the lymphocytes and fibroblasts. J. B. Murphy, however, recently showed through very ingenious experiments that in the case of heterotransplantation also lymphocytes, under certain conditions, may be of importance as a defensive mechanism of the host.

It has likewise been shown by such investigators as Burgess, DaFano, Baeslack, Rous and J. B. Murphy, that in the case of tumors against which an immunity becomes established, lymphocytes sometimes, in conjunction with other leucocytes, play a distinct rôle in the destruction of the tumor tissue. This holds good in the case of tumors already established. If immunity is produced before the transplanted tumor has united with the host tissues, the ingrowth

of fibroblasts and blood vessels into the transplanted tissue may, according to Russel and Woglom (in the case of tumors) and Peyton Rous (in the case of embryonic tissues) be delayed or else diminished in amount. However, even in the latter case the defence of the organism against the foreign tumor cells may principally consist in an attack by lymphocytes and other leucocytes (E. E. Tyzzer).

As the most probable explanation for these phenomena, we have proposed the following theory:[5] The mutual chemical incompatibility of the body fluids of one individual and the tissues of another, which we could especially clearly demonstrate after homoiotransplantation of pigmented skin, leads to changes in the metabolism of the tissues, resulting in the production of homoio- and heterotoxins, which if they do not exceed a certain strength, disturb the normal functions of the transplanted tissues to some extent without, however, interfering seriously with their life. But the abnormal products formed attract the lymphocytes and in certain cases also other leucocytes, and alter the reaction of the fibroblasts, which latter are induced to produce dense fibrous tissue. If the poisons become more active, they may directly injure tissues to such an extent that growth and life become impossible.

These conclusions, as we believe, also throw light on so-called chronic inflammatory processes of various organs where a changed metabolism of the cells, and perhaps also poisons produced by microorganisms, may induce fibroblasts to form fibrous bands and attract lymphocytes, thus leading to processes of cirrhosis. In a similar way, in the case of tumor immunity, which, for instance (as Clowes and Gaylord have shown), exists in the case of the retrogression of tumors, substances produced as a result of immunization and which circulate in the body fluids alter the metabolism of the tumor cells, which in turn influence the activity of the lymphocytes and fibroblasts in a way similar to normal tissues in a strange host. This theory correlates the immunity against tumor and tissue growth with the immunity against certain substances and non-growing foreign cells. We have also in the former case to deal with the production of immune substances, which, however, in the case of homoiotransplantation, are usually not such that they directly destroy the foreign tissues, but merely lead to an alteration of their metabolism and to the production of substances which change the behavior of the host cells. We no longer need to assume a primary tissue alteration following the homoiotransplantation.

It remains for further investigations to decide to what extent the presence of foreign tissue leads to the direct production of what we could call primary homoio- and heterotoxins as the result of the interaction between the preformed constituents of the body-fluids and the foreign cells, and to what extent it leads to the production of secondary homoio- and heterotoxins—the immune substances—as the result of immune reactions. At present it appears probable that both these substances play a rôle. In vitro the toxicity of body fluids of foreign species is apparently not very marked, as we, as well as Lambert, found. The toxicity is certainly less than we should expect, considering the fate of tissues after heterotransplantation. We must, however, take into account the fact that the amount of body fluid and especially of toxin acting on the tissue in vitro, is extremely small as compared with the quantity acting in the

[5] Leo Loeb, "The Influence of Changes in the Chemical Environment on the Life and Growth of Tissues," *Journal American Medical Association*, Vol. 64, February, 1915, p. 726.

living body, and that this reduction in the quantity of body fluid is very much greater than the reduction in the quantity of tissue. Furthermore, in the body the fluid in contact with the tissue is constantly renewed and the old fluid is eliminated. In vitro the fluid remains relatively constant. There exists also the possibility that the action of the body fluid is a complex one in vivo in a way similar to the complex action after homoiotransplantation. In the case of both types of substances (those preformed and those produced through immunization), we are able to point to analogous substances existing elsewhere, namely, the preformed species-specific tissue coagulins, which play a rôle in the blood coagulation, and the secondarily, artificially produced antibodies of various kinds. It also remains further to be determined, how far the metabolic products of foreign cells exert a direct influence upon each other and how much of this effect is dependent upon the interaction between cells and foreign body fluids.

In addition to the effect of toxic substances, mere lack of common food-stuffs can also retard tumor growth, as the retarded growth of transplanted tumors in pregnancy and the feeding experiments of Moreschi, Peyton Rous, Beebe, Sweet, Corson White, and Saxon, Robertson and Burnett have shown. Other substances apparently stimulate tumor growth (Robertson and Burnett). Whether an immunity caused through the lack of specific substances—in contradistinction to the common food and growth stuffs of cells—whether, in other words, an athreptic immunity, as Ehrlich called it, exists, however, is very doubtful. Such an athreptic immunity certainly would not explain the phenomena referred to above, as especially the experiments of Uhlenhuth, Haendel and Steffenhagen, Tyzzer and Levin have shown.

In the retarded cancer growth in pregnancy especially we do not have to deal with a scarcity in specific growth substances, particularly in hormones, as Ehrlich supposed, but with a shortage in the ordinary substances required for the building up of cells. On the contrary, it seems to us very probable that certain hormones which circulate during pregnancy may be of advantage to tumor growth, and that these two antagonistic factors—deficiency in ordinary building material and presence of special hormones—may preponderate unequally in different cases and thus the difference in the effects on tumor growth which certain investigators found in pregnancy may be explained.

In connection with the studies in metabolism to which we have just referred, we may look forward to interesting results through further analysis of the chemical constitution of tumor tissues.

I am, however, inclined to regard the differences so far found between normal and tumor cells in a similar light, as differences observed in the case of mitotic division in normal and tumor cells, both probably being the result and not the cause of the changes in the growth energy characteristic of tumor cells.

Having arrived at the end of our survey, we must confess that much remains still to be done before these investigations can in any way be considered near completion. On the other hand, I believe that I have indicated that there are yet other ways open for further attack upon the problems of cancer and tissue growth, and I hope also that I have been able to convey the impression that the work of so many investigators in this field has not been in vain, and that not only this special branch of science has been built up, but that also biology

and pathology in general have been stimulated and enriched as the result of their labors.

LEO LOEB
DEPARTMENT OF COMPARATIVE PATHOLOGY,
WASHINGTON UNIVERSITY

THE UNITED STATES FISHERIES BIOLOGICAL STATION AT BEAUFORT, N. C., DURING 1914 AND 1915

THE laboratory of the U. S. Fisheries Biological Station at Beaufort, N. C., has been open for investigators each summer for the past seventeen years. Below is given a brief summary of the various activities of the station during the years 1914 and 1915.

The many improvements and repairs effected during the past two years have contributed materially to the appearance of the small island on which the station is located, and to the working efficiency of the laboratory. The grounds were graded and covered with a coat of black top soil in which grass was planted and grown with success. An additional breakwater was built, the terrapin pounds were enlarged, and a fish pool and tide pool were constructed. The cedar post foundation of the main building was replaced by brick piers, the old coal house was rebuilt into a boat house, connected with marine boat ways, and a new coal bin connected with the power house was constructed. About 338 square feet of concrete walks were laid. Porches were constructed across the ends and south side of the dormitory rooms. These added much to the appearance of the building and the comfortableness of the bed chambers. A library room and a small laboratory have been provided on the lower floor of the main building. The power house has been equipped with a salt-water pump of such ample dimensions that the 10,000-gallon salt-water tank can be filled in about one seventh of the time previously required, with a consequent saving in labor and fuel. A new projection and micro-photographic apparatus was added to the laboratory equipment.

Under the direction of the librarian of the central office of the Bureau the library has been systematically arranged and catalogued. The number of volumes has been increased by both purchase and voluntary contributions of publications on biological subjects from various authors and institutions.

Most of the investigators who were employed during the past two years had been with the laboratory before, and continued lines of work begun previously. Professor H. V. Wilson, of the University of North Carolina, was at the laboratory for a short time during both summers. He continued the study and identification of the Albatross-Philippine sponge collection. Nearly all the forms studied differ in more or less important respects from described forms and most of them will be published as new species or varieties.

Dr. S. O. Mast, of Johns Hopkins University, was with the laboratory during the summer of 1914 and continued his studies of the previous season on the changes in shades, color and patterns in fishes, with especial reference to the flounders, *Paralichthys* and *Ancylopsetta*. He also made some observations on the behavior of *Fundulus majalis* in tide pools.

Dr. Mast was unable to demonstrate that adaptation to background in the above-named flounders has any biological value. Experiments, however, indicate that there is in flounders a tendency to select bottoms which harmonize with their skin in color as well as in shade. It was also shown that flounders do not compare their skin with the bottom in the process of adaptation, but that this is regulated solely by the effect of light received by the eyes from above and by its reflection from the bottom. The results of Dr. Mast's work also indicate that the fusion rate of images on the retina for flounders and for man is the same.

With reference to the behavior of *Fundulus majalis*, Dr. Mast's observations indicate that this fish has a sense of direction probably somewhat similar to certain birds. It was noticed many times that when a school of these fish was left in a tide pool as the water fell they left the pool and crossed a sand bar, continuing their flops toward the sea until water was reached, and seldom making the mistake of coming out on the wrong side of the pool.

Dr. Albert Kuntz, of the St. Louis University School of Medicine, during the summer of 1914 continued for the third season his investigation of the breeding habits, embryology and larval development of the fishes of the vicinity. His observations for the season were based exclusively on living material on the eggs and larvæ of five species of teleosts, viz.; *Cyprinodon variegatus, Lucania parva, Kirtlandia vagrans, Gobiosoma bosci* and *Ctenogobius stigmaticus*. The eggs of each species were fertilized and hatched in the laboratory.

Drawings illustrating different stages of development were prepared by Mrs. Decker, an artist, employed for the station. The chief purpose of this work was to give descriptions, along with the illustrations, that would afford ready means of identifying the eggs and larvæ of the species studied.

Mr. H. F. Taylor, then of the Tarboro High School, Tarboro, N. C., now an assistant in the Bureau of Fisheries, devoted the season of 1914 almost exclusively to the study of the scales of the menhaden (*Brevoortia tyrannus*). The results of Mr. Taylor's work indicate that this fish lives to be five or six, or rarely seven years old, and that it spawns about the fifth year. The year groups have approximately the following lengths; first year, 9 cm.; second year, 15 cm.; third year, 18.5 cm.; fourth year, 20 cm.; fifth year, 22 cm.; sixth year, 24 cm.; seventh year, 26.5 cm. The indications also are that the spawning time is very protracted or that there is a secondary spawning time in addition to the regular November spawning.

Prof. W. P. Hay, of the Washington, D. C., high schools, continued his experiments of previous seasons in diamond-back terrapin culture, the study of the life history of the blue crab, and the report on the decapod crustaceans of the Beaufort region.

The present series of experiments in diamond-back terrapin culture were first undertaken at this station in 1909. Since that time nearly 6,000 young terrapins have been hatched in the ponds at the laboratory. The brood of 1914 numbered 1,631 on November 10, an increase of 207 over the total number of the 1913 brood. The 1915 brood numbered 2,035 on the same date of the present year. Nearly 2,000 young terrapins, representing the various broods, are retained at the station for experimental purposes. A marked improvement in the size and vigor of the broods from year to year is apparent, indicating that the adult breeding stock is adapting itself more and more to life in captivity. The various broods are divided into two or more lots each of which is handled differently in order to determine the best treatment of the animal in captivity. Some of the individuals of the broods of 1909, 1910 and 1911 have reached a marketable size, *e. g.*, six inches or more in length, measuring the lower shell. The broods of 1909 and 1910 both produced eggs for the first time during the summer of 1915. The young hatched from these eggs, while they are vigorous and healthy, are notably smaller than the average size of those hatched from eggs produced by the adult breeding stock. During the winter of 1914 and 1915, nearly the entire brood of 1914 and 83 of the brood of 1911 were kept in the hot house. Contrary to the custom of previous winters, some of them were fed on fresh instead of salted food in order to determine the advantage or disadvantage of either. Those fed on fresh food had attained greater growth by spring when all were placed outside in concrete inclosures, after which, as usual, all were fed on fresh fish. When measured in September, 1915, the difference in size between the two lots was not so apparent. The brood of 1915 is being kept in the hot house and the experiment of the previous winter with reference to fresh and salted food is being continued.

On the study of the life history and behavior of the blue crab, Mr. Hay reports that the data collected indicate that the intervals between moults and the amount of growth at moulting time is quite variable and is determined by the amount of the food supply. The crab probably attains sexual maturity at three years of age, when also it has usually attained its maximum normal growth and then ceases to moult.

The report on the decapod crustaceans of the Beaufort region, which was originally be-

gun by Dr. C. A. Shore and later continued by Mr. Hay, has been nearly completed and will probably go to press at an early date.

Dr. H. S. Davis, of the University of Florida, devoted the two seasons to the continuation and completion of investigations on the Myxosporidian parasites of fishes occurring in the Beaufort region. The parasites are common in nearly all the fishes of the region. There is in fact scarcely a species which is not infested by one or more species. The results of these investigations have been embodied in a paper on the Myxosporidia of the Beaufort Region, which is nearly ready for publication.

Dr. James J. Wolfe of Trinity College, Durham, N. C., during both seasons under consideration continued his experiments on the brown alga, *Padina,* and the examination of the *Diatomaceæ* of the Beaufort region. It is expected that a paper covering the results of the experiments on *Padina* will soon be published. Dr. Wolfe is preparing a rather extensive and profusely illustrated report on the diatoms. Many microphotographic plates, which were retouched by the artist, have already been prepared.

Dr. L. F. Shackell, of the St. Louis University School of Medicine, continued his experiments begun in 1912 on the preservation of wood against marine borers. During the past two seasons these studies were carried on in collaboration with the staff of the U. S. Forest Products Laboratory, Madison, Wisconsin. A special study was made of the toxicity of coal-tar creosote and its fractions for certain borers. During the season of 1914 the common ship worm, *Xylotrya,* was used in the experiments, and during 1915 the common wood-boring crustacean, *Limnoria,* was used in the same series of experiments. The results were about the same for each. The results of the 1914 experiments have already been recorded in the *Proceedings* of the American Wood Preservers' Association for 1915. During the summer of 1915 specimens of wood treated with various coal-tar creosote preparations were exposed to the water of the harbor. These specimens are, of course, to be carefully examined in order to determine the effectiveness of the different treatments.

Dr. William L. Dolley, Jr., of Randolph-Macon College, began in 1914 an investigation of the copepods of the Beaufort region. Collections were made and forms occurring most frequently were identified. Unfortunately Dr. Dolley's work was greatly interrupted by sickness. Dr. Dolley was unable to return for the continuation of this work during the summer of 1915.

Dr. C. H. Edmondson, now of the University of Oregon, formerly of the University of Iowa, continued during the summer of 1915 the collection and identification of the foraminifera of the Beaufort region. During the past season over two hundred species were collected and provisionally identified and taken to the university for further study.

Mr. Radcliffe, of the Bureau of Fisheries, Washington, D. C., was at the laboratory during the summer of 1914. He continued the work of the report on the sharks and skates of the Beaufort region and had charge of the work done by the *Fish Hawk* during its stay in the vicinity.

Professor O. W. Hyman, of the University of Tennessee, during the summer of 1915 made some investigations regarding the artificial propagation of the common clam, *Venus mercenaria.* It was, however, determined that the spawning season was nearly over, and that this work should be undertaken earlier in the season, *e. g.,* probably as early as April. Mr. Hyman also worked on the early larval forms of certain decapod crustaceans of the Beaufort region. Of ten forms the first zœas were secured, in six of them the second zœas and in three the third zœas were secured. The method of procedure in each case was to get a ripe female with eggs and keep her in the laboratory until the eggs hatched. Each stage of the zœa was described and drawn with camera lucida.

Mr. Arthur Jacot, of Cornell University, spent the season of 1915 at the laboratory making a study of the mullets of the vicinity with especial reference to their spawning habits and the young, or *Querimanna* stage. It had been noticed by the director that young of one inch and less in length could be obtained throughout the year. It had also been reliably reported by

fishermen that mullets with roe are occasionally taken during the spring of the year. These mullets were identified by the fishermen as the common jumping mullet, *Mugil cephalus,* which species is pretty definitely known to spawn in this vicinity during the fall of the year.

Mr. Jacot found that all of the young of one inch and less in length taken during the winter are *Mugil cephalus,* and all of those taken during the summer are *Mugil curema.* This is very interesting in view of the fact that the adults of the latter species are rare in the vicinity, while the young are quite abundant. The exact spawning grounds of the mullets is not known, neither has it been possible to obtain young much less than three fourths of an inch in length. For these reasons the probability of an early migration of the young presents itself, and the knowledge now gained may finally aid in locating their spawning grounds.

Mr. H. S. Willis, a medical student of the Johns Hopkins University, who was with the laboratory in 1915 was detailed as naturalist aboard the steamer *Fish Hawk.* Besides this he made some camera lucida drawings for Dr. Mast of scales of flounders that had been held on variously colored backgrounds for a long period of time. He also rendered considerable assistance to the director in the preparation of a report on the teleosts of the Beaufort region.

Mrs. Effie B. Decker, of Washington, D. C., an artist, was with the laboratory during both seasons. She made illustrations and retouched photographic plates for the various lines of work conducted by the station.

Besides the above-named individuals employed by the Bureau the following persons visited the station as independent workers: Mr. W. C. George, of the University of North Carolina, spent a portion of June and July, 1914, at the laboratory investigating the Ascidians. He followed out the egg development of *Stylea plicata,* and studied some of the phenomena of degeneration and regeneration of *Perophera.*

Dr. G. L. Kite, of the Henry Phipps Institute, Philadelphia, spent about six weeks at the laboratory during June and July, 1914, devoting his time to the study of certain phases of the embryology of the white sea urchin *Toxopneustes* and that of the worm *Thalassema* which inhabits the dead tests of the sand dollar. Professor Ulric Dahlgren, of Princeton University, spent several weeks at the station during July and August, 1914, for the purpose of collecting the young of *Astroscopus y-græcum,* of the electric organs of which he is making an exhaustive study. His efforts at that time were, however, unsuccessful, as no young were obtained. Mr. August Webber, of New York, N. Y., spent about two weeks at the laboratory during August, 1915, collecting birds for the Brooklyn Institute and bird stomachs for the U. S. Biological Survey.

The director devoted such time as could be spared from other duties mainly to the study of the breeding habits of fishes. During April, 1913, Mr. Radcliffe examined a few specimens of flounders, identified as *Paralichthys lethostigmus,* containing roe. During 1914 and 1915 the spawning habits of the flounders were further investigated with the view of taking up the artificial propagation of these fishes if possible. No flounders containing roe were taken during the spring, but during the fall of each of these years several specimens have been secured with well-developed roe. In every case these were large females, which are comparatively rare. No male with developed roe has yet been observed.

The spawning habits of the weak fish *Cynoscion regalis* and the pig fish *Orthopristis chrysopterus* were also investigated. The data collected indicate that these species run out to sea to deliver their spawn. Data were also collected on the spawning habits of *Bairdiella chrysura,* and a number of minnows. Several experiments were performed in the laboratory with the viviparous species *Gambusia affinis* and with *Cyprinodon variegatus.* Data collected indicate that several of the minnows have a protracted spawning season, producing eggs throughout the greater part of the summer.

It is believed that the following species were taken for the first time in this vicinity during the past two years: (*a*) *Urophycis floridanus,* (*b*) *Menidia beryllina,* (*c*) *Sphyræna barracuda,* (*d*) *Fundulus ocellaris,* (*e*) *Fundulus*

luciæ. The last-named species appears to have been taken only twice previously, once on the New Jersey coast and later on the lower Potomac. This species is fairly common in the Mullet Pond and very abundant in the very shallow and muddy ponds on the marshes to the westward of the entrance of the canal on Newport River.

On July 16, 1914, a first-class can buoy, painted with red and white spiral stripes, was planted on the black-fish grounds off Beaufort as an aid to fishermen desiring the use of the bank. The buoy is 21⅓ miles S. by W. ⅞ W. of the whistle buoy on Beaufort Bar; 23½ miles SW. ¼ W. of Lookout Light; and 26 miles SE. by E. ½ E. of New River Inlet. These grounds have been pretty carefully surveyed and charted by the *Fish Hawk*. This bank is about six miles in length and over one half mile wide at the broadest point. It has been possible to obtain an abundance of fish there at all times when the bank was visited by the *Fish Hawk*. So far but little use has been made of this source of food supply, but it is hoped that in the near future fishermen will avail themselves of the opportunity there presented.

SAMUEL F. HILDEBRAND

ALVIN DAVISON

DR. ALVIN DAVISON, professor of biology at Lafayette College, Easton, Pa., died on the thirty-first of July. Dr. Davison was best known, perhaps, as the author of seven widely-used text-books on biological subjects—on zoology, physiology, anatomy and hygiene. He was also well known as the original advocate of the movement to dispense with the public drinking cup, as a frequent contributor to scientific magazines, as an able and entertaining lecturer and as a competent expert witness in both civil and criminal trials.

Although an author and scientific man of high standing, Dr. Davison will longest be remembered as a teacher. In September, 1894, he founded the department of biology at Lafayette, and since that time this department has turned out large numbers of biological workers who quickly assumed positions of leadership in the biological field. A number of well-known teachers of biology in the colleges of the eastern United States, and numerous entomologists, bacteriologists and foresters connected with the state and federal governments received their training under Dr. Davison.

A noted health worker recently wrote to the widow of Dr. Davison:

> I know he has meant a great deal to many students, but I doubt if the work and life of any one with whom he came into contact was more profoundly influenced by him than was my own. Any good I may have ever accomplished in the social and health field will be in large measure due to the sense of direction imparted to me by your husband while I was in his classes.

A professor of biology in one of our eastern colleges wrote:

> But for your husband my college course would have been largely wasted; but for him I would not now be engaged in the useful work I am doing.

Scores of similar communications attest the great influence which this unusual teacher exerted upon his students.

By inclination and training Dr. Davison was unusually fitted to pursue research work in science. After graduating from college, he took up postgraduate work at Princeton University, and later on studied in Freiburg under Weissman and Weidersheim. Although very fond of research work, and, as his books and magazine articles reveal, although he did no little amount of it, he felt that he could do a greater work for science by opening the eyes of others and starting them on the way he was traveling. He with Ruskin deplored the fact that "hundreds of people can talk where one can think and thousands can think where one can see." His greatest work was teaching his pupils "to see."

At the time of his death Dr. Davison was forty-eight years of age. Up to within a few days of his death he was busily engaged in working upon the eighth volume of his series of biology text-books.

H. D. BAILEY

MUHLENBERG COLLEGE

PRESENTATION OF A PORTRAIT OF J. PETER LESLEY

The University Day program at the University of Pennsylvania, on February 22, included the presentation of a portrait of the late J. Peter Lesley, who was professor of geology and mining from 1872 to 1890, and subsequently professor emeritus of geology and mining until his death in 1903. The portrait is the gift of Joseph G. Rosengarten, and was painted by Lesley's daughter, Mrs. Margaret Lesley Bush-Brown. The presentation address was made by Professor Amos P. Brown, who said:

Mr. Provost: I have the honor to present to the university, on behalf of the donor, this oil portrait of J. P. Lesley, late professor of geology and mining in the University of Pennsylvania; and it seems as appropriate as it is fortunate that the artist could be his own daughter, Mrs. Margaret Lesley Bush-Brown. Peter Lesley, topographical geologist and expert, characterized as "one of the most distinguished and lovable men of science in the United States," was born in Philadelphia on the 17th of September, 1819; he died at Milton, Massachusetts, on the 1st of June, 1903. Throughout a long life he was always, primarily, a student of geology. He entered the University of Pennsylvania at the age of fifteen, and after winning high honors, including his Phi Beta Kappa, he was graduated a Bachelor of Arts with the class of 1838 C. In the same year he began his geological career as aid, under Henry Darwin Rogers, on the recently initiated First Geological Survey of Pennsylvania. It was then that he commenced those studies in Appalachian structure in which he afterwards became so preeminent a master, and which made him rank as the foremost geological expert in his state. This position not only brought him much employment in his profession, but also brought with it many honors; he was selected as one of the original members of the National Academy of Sciences at Washington, in 1863, given the degree of Doctor of Laws by Trinity College, Dublin, in 1878, and he received a gold medal from Paris "for original investigations" in 1889. When the university was removed from the center of the city to West Philadelphia in 1872, Dr. Lesley was appointed professor of geology and mining, and dean of the science department; and when, three years later, the Towne Scientific School was opened, he was made its first dean. But the crowning honor of his career came with his appointment as director of the Second Geological Survey of Pennsylvania in 1874, a position for which he had no competitor. To quote Sir Archibald Geikie, himself the head of a geological survey: "The one hundred and twenty volumes of this survey issued under his direction, and the Summary Final Report, more than half of it from his own pen, will form the noblest monument to the genius of J. P. Lesley."

In accepting the portrait, Provost Smith said:

J. Peter Lesley was indeed preeminent as a geologist. His discoveries live because of their fundamental character. The university in which he received the academic training, and to which he gave the best years of his life as a teacher, deeply appreciated his successes and rejoiced in the universal recognition accorded him as a scientist. The trustees of the university are glad to have this portrait and, through me, return their sincere thanks to the thoughtful and generous donors.

SCIENTIFIC NOTES AND NEWS

Sir F. W. Dyson, the English astronomer royal, and Dr. C. S. Sherrington, professor of physiology at Oxford, have been elected corresponding members of the Petrograd Imperial Academy of Sciences.

The Paris Academy of Medicine has elected as foreign correspondents Professor Ladame, of Geneva, and Sir Dyce Duckworth, of London.

At the Royal College of Physicians of London, Sir Thomas Barlow is to be the Harveian orator for the present year, Dr. H. W. G. Mackenzie the Bradshaw lecturer, and Dr. W. J. Howarth the Milroy lecturer for 1917.

Dr. Ira Remsen, of Johns Hopkins University, addressed the Chemical Club of Princeton University, on February 18, on "Reminiscences of Liebig and Wohler."

The Vanuxem lectures at Princeton University are being given by Dr. Thomas Hunt Morgan, professor of experimental zoology in Columbia University, on February 24, March 1, 8 and 15. The subject is "A Critique of the Theory of Evolution." Professor Morgan has

been invited to give in the spring the Hitchcock lectures at the University of California.

DR. E. NEWTON HARVEY, assistant professor of physiology at Princeton University, will leave for Japan about March 18 to study the production of light by luminous animals. The trip is under the auspices of the department of marine biology of the Carnegie Institution of Washington.

DR. C. J. MARSHALL, professor of veterinary medicine in the veterinary school of the University of Pennsylvania, will sail from New York on the steamer *Rotterdam* on March 7, visiting England and France to make observations in the hope that the information obtained will be of service to America.

ANDREW H. PATTERSON, head of the department of physics at the University of North Carolina, is on leave of absence from that institution and is with a corporation in New York City.

To further the work begun by Dr. Samuel J. Barnett, of the department of physics of the Ohio State University, as to the cause of the earth's magnetism, the board of trustees of the university has appropriated $300.

THE survey of the fish of Oneida Lake begun last summer by the New York State College of Forestry, at Syracuse, will be continued this summer. This work, under the supervision of Dr. C. C. Adams, was carried on with the cooperation of Professor T. L. Hankinson and Frank C. Baker. Beginning in June, the work will be continued by Messrs. Adams and Hankinson. Last summer the western half of the lake was covered and this season the remainder of the lake will be surveyed. Mr. Frank C. Baker's report on the relation of molluscs to Oneida Lake fish is completed and will soon be published by the college.

THE board of health will celebrate the semicentennial of its sanitary control of New York City and adjacent counties by a commemoration dinner to be given March 9. Among the speakers expected are the mayor of New York; the State Commissioner of Health; Surgeon-General William C. Gorgas, U. S. Army; Dr. Walter B. James; Mr. Henry Bruere, and Dr. Stephen Smith.

DR. MATTHIAS NICOLL, JR., has been appointed director of the division of public health education in the New York state department of health, and in addition will have supervision of epidemiologic investigations in the southern and eastern parts of the state. He succeeds Dr. C.-E. A. Winslow called to the Anna M. R. Lauder professorship in public health at Yale University.

A LECTURE on the history of science was given by Professor George Sarton, formerly of the University of Ghent, and editor of *Isis*, in the Doremus Lecture Theater, on February 24, at the College of the City of New York.

ON February 8, Professor George H. Shull, of Princeton University, addressed the Graduate Club of Rutgers College on "Practical Application of the 'Pure-Line' Idea of Johannsen."

ON the evening of February 8, 1916, Dr. Benjamin L. Miller, professor of geology in Lehigh University, lectured before the Harrisburg Natural History Society on his recent travels in South America.

DR. HENRY L. ELSNER, professor of medicine in Syracuse University College of Medicine, died suddenly of heart failure on February 17. Dr. Elsner was a graduate of the College of Physicians and Surgeons, Columbia University, and had achieved eminence both through practise and his critical contributions to scientific medicine. A work on "Prognosis," which has received high commendation from critics of repute, is just passing through the press.

MR. GEORGE STRICKLAND CRISWICK, assistant in the Royal Observatory, Greenwich, from 1855 to 1896, died on January 26.

DR. H. KLAATSCH, associate professor of anthropology at Breslau, died on January 7, at the age of fifty-two years.

EDMOND HECKEL, professor of materia medica at Marseilles, has died, aged seventy-three years.

THE Woman's Medical College of Pennsylvania has established a fellowship amounting

to $1,000 to be awarded annually to any medical woman of special ability who, following the undergraduate course, has completed at least one year of hospital service, including work in maternity wards, and one year of further practise. The amount is to cover twelve months of special work as fellow in obstetrics, with the condition that the holder of the fellowship shall thereafter continue the practise of obstetrics.

The Woman's Medical Association of New York City offers the Mary Putnam Jacobi fellowship of $800, available for post-graduate study. It is open to any woman physician for work in any of the medical sciences. The fellowship will not be awarded by competitive examination, but upon proof of ability and promise of success in the chosen line of work. Applications for the year 1916–17 must be in the hands of the Committee on Award by April 1, 1916, and should be addressed to Dr. Annie S. Daniel, 26 Gramercy Park, New York City.

According to the *Journal* of the American Medical Association the Rockefeller Institute for Medical Research has let contracts for the buildings for its work in comparative pathology near Princeton, N. J., as follows: laboratories at a cost of $90,615; power house and tunnels, $102,556; operating building, $27,838. The work is to be finished by September 1.

The Colorado School of Mines announces that the U. S. Bureau of Mines will move its laboratory from Denver to Golden early in June. The two institutions will cooperate in investigation work. R. B. Moore and ten assistants form the bureau staff.

The United Engineering Society of New York has issued the annual report of the Library Board for 1915. The revenue was $17,445, and expenditure $16,380. There were 12,820 visitors.

In a report of the fire which destroyed the chemical laboratory of Cornell University the *Alumni News* states that it was impossible to save a great amount of material on which no monetary value can be placed. Several members of the staff lost records and data, the work of years. Notes of experiments and researches, manuscripts and personal belongings were destroyed. Professor Dennis saved most of the material in his office but lost his notes of class-room work. Professor Chamot lost his most treasured records. Professor Bancroft's working library was destroyed, together with the records and files of the *Journal of Physical Chemistry*.

The museum of the Royal College of Surgeons of England has been closed since June last, the motive being the desire to safeguard the collection from destruction during air raids. All spirit preparations and some of the more valuable of the others are now stowed in the basement, but those who desire to study any particular specimen will be permitted to do so. The conservator, Dr. Keith, is still in attendance, and anatomical and other scientific work is carried on in the workrooms of the college.

An appeal, signed by 246 German and Austrian scientific men, has been made to the public not to cease to subscribe to scientific periodicals. Such periodicals, the memorialists state, are indispensable to scientific progress.

The New England Association of Chemistry Teachers held its fifty-fifth regular meeting on February 12, at Harvard University. The program included remarks by Professor Theodore W. Richards; an address on "Radium and its Contribution to Chemistry," by Mr. Gerald L. Wendt, Austin teaching fellow, Harvard University, and an address on "Transformations by High Pressure," by Professor P. W. Bridgman.

The eighth annual meeting of the National Committee for Mental Hygiene, held on February 2 in New York, was attended by a large group of distinguished alienists, social workers and philanthropists. Mr. Otto T. Bannard, the treasurer, announced that the Rockefeller Foundation had donated to the National Committee $22,800 for carrying on surveys of the care of the insane in sixteen states during the present year, supplementing gifts of Mrs. William K. Vanderbilt, Mrs. A. A. Anderson and Mr. Henry Phipps. The following offi-

EWING COLLEGE

cers were elected: *President,* Dr. Lewellys F. Barker; *Vice-presidents,* Dr. Charles W. Eliot and Dr. William H. Welch; *Treasurer,* Otto T. Bannard; *Medical Director,* Dr. Thomas W. Salmon; *Secretary,* Clifford W. Beers; *Executive Committee,* Dr. August Hoch, chairman, Dr. George Blumer, Professor Stephen P. Duggan, Dr. William Mabon, Dr. William L. Russell and Dr. Lewellys F. Barker; *Finance Committee,* Professor Russell H. Chittenden, chairman, Otto T. Bannard, Dr. Henry B. Favill and William J. Hoggson; *Committee on Mental Deficiency,* Dr. Walter B. Fernald, chairman, Dr. L. Pierce Clark, Professor E. R. Johnstone, Dr. Charles S. Little and Dr. Albert C. Rogers.

THE twenty-seventh session of the biological laboratory of the Brooklyn Institute of Arts and Sciences, located at Cold Spring Harbor, will be held in the summer of 1916. Special facilities are offered to investigators and two scholarships of $100 each are available for such. Courses are given in field zoology by Drs. Walter and Kornhauser; in bird study by Mrs. Walter and Dr. Ehinger; in comparative anatomy by Dr. Pratt and Mr. Hine; in beginning investigation, especially in animal bionomics and genetics by Drs. Davenport, Pratt and Walter; in cryptogamic botany by Dr. H. H. York; in systematic and field botany by Dr. Harshberger and Mr. Miller and in training for eugenical field work by Dr. Davenport and Mr. Laughlin. Class work begins on July 5; tuition is $30. The new announcement may be obtained from, and application for scholarships made to, Dr. C. B. Davenport, Cold Spring Harbor, Long Island, N. Y.

THE *Journal* of the American Medical Association states that the Amsterdam Genootschap ter Bevordering van Natuur-, Genees- en Heelkunde founded in 1790, held recently its one hundred and twenty-fifth annual meeting when Dr. C. C. Delprat reviewed its history and achievements. The address is published in the opening number of the *Nederlandsch Tijdschrift voor Geneeskunde* for 1916, which begins its sixtieth year. It is accompanied by a dozen engravings showing the amphitheater for teaching of anatomy, 1690; lecture room, 1760; hospital, 1763, and a number of early officers of the society. The gala meeting was presided over by Professor G. van Rijnberk, who is also editor of the *Tijdschrift.* The society awards the Swammerdam medal every tenth year. The four recipients have been the Germans, Siebold, Haeckel and Gegenbaur, and the Netherlands scientist, Hugo de Vries. The Tilanus medal has been awarded every five years since the death of this eminent surgeon. It is given for the best work on some surgical or medical subject, and has been awarded to Zwaardemaker, C. de Mooy, L. Bolk and J. Boeke, all of the Netherlands. The society also distributes some stipends to medical students for study abroad, and has officially contributed to a number of endowment funds in honor of various foreign scientific men.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Buffalo has received actual and provisional endowment for the new department of arts and sciences amounting to $750,000. $100,000 of this sum to be given outright by Mrs. Seymour H. Knox, who, with her children, proposes to increase this eventually to a total of $500,000. $250,000 is given by General Edmund Hayes for the first building upon the university site, provided $1,000,000 be raised for like purposes before June, 1919.

PRESIDENT GOODNOW at the commencement exercises of the Johns Hopkins University, on February 22, announced that the Consolidated Gas Company of New York, the American Gas Company of Philadelphia and the Consolidated Gas Company of Baltimore had interested themselves in the establishment of a laboratory at the university for research work as to the possibilities of coal tar products. The purpose is to develop the aniline dye industry and other important branches in the coal tar field.

THE Graduate School of Agriculture will be held at the Massachusetts Agricultural College July 3–28, 1916. This school is under the auspices of the Association of American Agricultural Colleges and Experiment Stations. Dr.

A. C. True, of Washington, D. C., is the dean of the school, and the assistant dean is Professor Charles E. Marshall, director of the graduate school and professor of microbiology at the Massachusetts College. The school is open to all college graduates. Its purpose is for the study of the recent development in the natural, social and economic sciences as applied to agriculture, as well as in the technical branches of the so-called practical agriculture. Courses are offered in (1) growth, (2) production, (3) rural organization, (4) agricultural education, (5) distribution-marketing, (6) land problems, (7) adjunct course in physico-chemico-physiological elements, (8) special lectures and conferences.

From May 1 to November 30, fourth-year medical students at Toronto will be given a summer course to qualify for their degree, and there will be no fifth-year course next year at the university. The summer session will last twenty-six weeks. There will be sixty men who will attend the summer session, and when they graduate they will be in a position to accept positions with the various hospital units. It is understood that Queen's University, Kingston, will take a similar step.

The trustees of Northwestern University at their last meeting filled the vacancy in the deanship of the dental school, which occurred through the death of Dr. Greene Vardiman Black on August 31 of last year, by the election of Thomas Lewis Gilmer, M.D., D.D.S., Sc.D.

At Smith College, Dr. Joel E. Goldthwaite has been appointed professor of hygiene and physical education, and Miss Pauline Sperry, assistant professor of mathematics. Miss Harriet R. Cobb has been promoted to be professor of mathematics; Dr. Mary M. Hopkins to be associate professor of astronomy, and Mrs. Anna B. Newell to be assistant professor of zoology.

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DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL EQUATION OF MECHANICS

Mr. Kent's recent letter on the "Teaching of Elementary Dynamics,"[1] with much of which I heartily agree, contains one serious error which I think should not pass unnoticed. As this error seems to me a not unnatural result of one feature of his favorite method of beginning the study of mechanics, I should like to take this opportunity to summarize, in a brief review, the three methods of beginning mechanics which have been advocated respectively by Mr. Kent, Professor Hoskins and myself.[2] To do this, I propose first to state briefly certain *dynamical principles on which we all agree;* I shall then endeavor to show that precisely these non-disputed facts *are all that the student needs to know in order to solve dynamical problems, provided he follows my method.* It is only when he endeavors to follow one of the other methods that he is led into controversial territory. If undisputed facts are sufficient for the solution of problems, why burden the student's mind (except as a matter of historical interest) with needless disputations?

I. The following statements will, I believe, be accepted as true by all of us, though the emphasis placed on the various items would doubtless vary.

1. A *force* is a familiar notion which may be thought of as a push or a pull. Any given force may be *identified,* that is, preserved for

[1] Science, December 24, 1915.

[2] See articles in Science by L. M. Hoskins, December 4, 1914, April 23, May 7, August 27 and September 10, 1915; by E. V. Huntington, February 5 and July 30, 1915; and by William Kent, March 19 and December 24, 1915.

reference, by noting the distance it compresses an (idealized) standard spring.

2. To *measure* a force, we require a *unit* force, and a *scale* of multiples and submultiples of that unit. Such a scale can be readily constructed by simply opposing one or more springs, in various combinations, against the standard, or unit, spring. (This process of calibrating a spring balance does not involve any assumption in regard to Hooke's Law; it requires merely that the elastic properties of the spring, whatever they may be, do not, in the ideal case, vary with the time.)

3. A *material body,* or lump of matter, is a familiar notion, in the sense that if any material is added to or taken away from the body, it ceases to be the same body. (In this discussion, "body" is used in the sense of "particle," that is, a body which may be supposed, for the purpose in hand, to be concentrated at a single point.)

4. A *motion* of a body, with respect to a given frame of reference, is also a familiar idea. The scientific concepts of *velocity* and *acceleration* serve merely to make quantitatively precise our qualitative notions of "faster" and "slower."

5. The *effect of a force* when applied to a body free to move, is to *change the velocity* of the body. As a matter of common observation, the force required to produce a given change of velocity in a given time is larger for some bodies than for others.

6. *If a given body is acted on, at two different times, by two forces, F and F', and if a and a' are the corresponding accelerations, then*

$$F/F' = a/a';$$

that is, in the case of any given body, *the accelerations are proportional to the forces.* This statement is best regarded as a scientific hypothesis, the consequences of which have been abundantly verified by experiment.

7. In order to *predict the behavior of any given body* under the action of various forces (and this is the central problem of dynamics), it is sufficient, and necessary, to know from some (direct or indirect) experiment, what acceleration some one force would produce in that body. The acceleration, a, that would be produced by any other force can then be computed at once by the fundamental proportion.

In the special case in which the acceleration a is constant, and the body starts from rest, $v = at$ and $x = \frac{1}{2}at^2$; in the general case, v and x must be obtained from a by integration.

The foregoing items 1–7 are quite general;[3] the following, 8–11, are suggested primarily by observations on the earth's surface.

8. The observed acceleration, g, of a freely falling body, in any locality, is the same for all bodies. By the "standard locality" is meant any locality (for example, approximately 45° latitude, sea level) in which $g = g_0 = 980.665$ cm./sec.^{2} $= 32.1740$ ft./sec.^{2}, this being the convention now generally adopted.[4]

9. (*a*) *The force required to support a body at rest with respect to the earth in the standard locality,* and (*b*) *the force which would give that body, if free to move* (in any locality) *the standard acceleration g_0, are the same.* This force, which is characteristic of the given body, is what I have called the *standard weight,* W_0, of the body.[5] By the fundamental proportion, if F is any other force, and a the corresponding acceleration, then $F/W_0 = a/g_0$.

10. The "standard weight" of a body can always be found (in any locality) by the familiar process of "*weighing*" *the body on a beam balance.*

For example, suppose a given body balances

[3] The principle of action and reaction, the principle of the vector addition of forces and the principle of the independence of two perpendicular forces, together with the definitions of such terms as work, kinetic energy, impulse, momentum, etc., although necessary for the development of the science, may be passed over without comment, as they are not now in dispute.

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a "1 lb. weight" in a given locality; this means, primarily, that the force required to support the given body, in the given locality, is equal to the force required to support the "1 lb. weight" in that locality; hence, by a simple inference, the force required to support the given body in the standard locality will be equal to the force required to support the "1 lb. weight" in the standard locality; but the force required to support the "1 lb. weight" in the standard locality is guaranteed to be "1 lb."; hence the force required to support the given body in the standard locality—that is, the "standard weight" of the body—is also 1 lb.

11. Finally, *if the standard weight of a body is known, the dynamical properties of the body are wholly determined.* For example, if we wish to find the acceleration, a, produced by any force F in a body whose standard weight is W_0, we have merely to substitute the given values in the equation $F/W_0 = a/g_0$ and solve for a.

In other words, the simple principles enumerated above—principles the truth of which has not been called in question—form a complete and satisfactory foundation for the solution of elementary problems in dynamics. It should be particularly noted that no restrictions whatever are imposed on the choice of the fundamental units of force, length and time; and that the only datum that we need to know in advance concerning any body that enters a problem is a single, readily determined force, namely, the standard weight of the body.

II. Let us now turn to Professor Hoskins's method, and inquire what items one of the very best of the modern text-book writers regards it as necessary to add to these familiar principles.

In his article in Science for April 23, 1915, page 608, he says:

> The method most intelligible to the beginner is to introduce at the outset the body-constant which was called by Newton mass or quantity of matter, and to make the fundamental principle . . . the following: (*a*) A force acting upon a body otherwise free would give it, at every instant, an acceleration proportional directly to the force and inversely to the mass of the body.

His fundamental equation is therefore

$$\frac{a}{a'} = \frac{F}{F'} \cdot \frac{m'}{m},$$

which is immediately thrown, by a perfectly arbitrary restriction on the choice of units, into the final form: $F = ma$.

It will be noticed that this method of Professor Hoskins, and most other authors, involves four fundamental concepts, namely, force, length, time and mass; while my method involves only three, namely, force, length and time. My chief objection to this complication is not merely that the fourth concept, mass, is superfluous, *as a fundamental concept,* but also that this concept is, *at this stage,* exceedingly ill-defined. Nowhere in Professor Hoskins's papers can one find a clear-cut statement of what he really intends the student, at the outset, to understand by mass. If he means merely that m is a quantity proportional to F/a, and m' a quantity proportional to F'/a', which relations are consistent with his fundamental equation, of course no one could object to this use of symbols; but the compound quantity F/a, or W/g, which is properly called the *inertia* of the body, can surely not be understood "at the outset," before the elements out of which it is built up have been grasped; and this is clearly not Professor Hoskins's intention.

His several attempts to point out certain rather vague analogies between the concept of mass or inertia and certain other concepts,[6] have altogether failed to provide a satisfactory justification for his use of mass as a term the meaning of which can be presupposed at the outset, for nowhere does he really define the term, and nowhere does he squarely meet the objections which I have raised to this procedure.

A further objection to the equation $F = ma$, which I have dwelt upon at length elsewhere,[7] is in regard to the question of units. The choice of units which the use of this equation compels is needlessly complicated and quite

[6] L. M. Hoskins, Science, September 10, 1915.

[7] See especially Science, July 30, 1915, page 160.

unscientific. On this point I heartily endorse Mr. Kent's somewhat pungent criticisms, which are entirely in accord with previous expressions of my own.

III. Finally, let us examine Mr. Kent's method. Like Professor Hoskins, Mr. Kent introduces mass, or quantity of matter, at the outset, but unlike Professor Hoskins, he frankly defines what he means by this term—namely, the result of weighing on a beam balance. This same plan is followed by several of the writers who have taken part in this discussion, notably by Franklin and MacNutt.[8] There is no logical objection to this procedure; but—*cui bono?* The result of weighing a body on a beam balance gives primarily the standard weight of the body as we have seen in (10), above; if the standard weight of a body, which is simply a force, and which everybody understands, is all that is needed, why rename this familiar concept by a less familiar term, like "quantity of matter"? Further, what are the "dimensions" of "quantity of matter"?[9] Is it of the nature of a force, or, like inertia, of the nature of a force divided by an acceleration? Or is it wholly independent of force, length and time (in which case it is wholly superfluous)? Without doubt, *later in the course* any terms of this sort may be introduced at pleasure; but why confuse the *beginner* with any concepts that are not really needed? The elimination of this one term, quantity of matter, would bring Mr. Kent's method almost exactly into line with my own, except for one point.

This remaining point of difference, though slight, is, at least from the point of view of the teacher, an important one. My method begins frankly with the idea of acceleration as a fundamental concept—not an easy idea, but one which is so essential that the student does best who faces its difficulty squarely at the outset. Mr. Kent's method, on the other hand, begins with the comparatively simple special case in which the acceleration is constant, and introduces the real thing only later on, as a sort of afterthought. For a student who is never to go further than the special case, the method based on Mr. Kent's equation $V = FTg/W$ is well enough; and this is what I had in mind when I said that "the method was not without interest on the pedagogic side." But for the student who pursues the subject seriously, the plan of spending so much time on the simple special case is too apt to have only one result, namely that the development of an unerring, instinctive grasp of what acceleration really means is either long delayed or never attained. And this brings me to the question of the error in Mr. Kent's paper. On page 902 he asks the question:

> How can a body at rest on the earth's surface have an acceleration . . . radially toward the earth's center . . . if there is no change in the speed of rotation of the earth?

The old error of supposing that a particle moving with constant velocity in a curved path has no acceleration!

Now I have no doubt that if the matter were called to his attention, Mr. Kent would at once remember that a particle moving with a constant velocity in a circular path certainly does have an "acceleration radially toward the center," the value of which is v^2/r; but the point I am making is that in the rush of the moment he did *not* remember this most cardinal fact about accelerated motion; and I attribute the possibility of a man of his experience making a slip of this kind entirely to the grudging fashion in which the subject of acceleration was probably presented to him in his first course in mechanics—a precedent which my method refuses to follow.

EDWARD V. HUNTINGTON
HARVARD UNIVERSITY

[8] Franklin and MacNutt, SCIENCE, July 9 and September 24, 1915. In regard to the supposedly contrasted statements (*a*) and (*b*) on page 423 of their second article, it may be remarked that these authors have apparently overlooked the fact that each of these statements is a direct mathematical consequence of the other, as one may readily see by an inspection of their diagram on page 422.

[9] Mr. Kent is apparently quite oblivious of the value of the theory of dimensions, as he uses the same letter (g) quite indiscriminately to denote a length, a velocity, an acceleration, or a pure number!

POLARIZATION OF GLOBIGERINA

On examining a group of ancient microscopic slides of modern foraminifers it was found that they polarize very beautifully, showing with plane polarized light several concentric circular spectra and a very clear black cross with broad bands and a broadened central area. This appeared most perfectly with globigerina, the young forms with but a single globe showing most perfectly. In the larger forms each half enveloping globe shows the same phenomena very clearly. The spectral rings are crowded toward the edge of the sphere and the explanation is clearly that the hollow sphere is in effect a circular wedge with its thinnest part at the center and becoming thicker radially, at first gradually and at last much more rapidly.

It was found also that minute valves of a bivalve, in shape like a quahog, would do exactly the same things only the rings were pear-shaped with a projection at the beak of the shell and broader and brighter. It was clear that the very sharp black cross was due to the fact that the outer layer of the shell is fibrous and we may deduce that the similar black cross in the globigerina is due to a minute fibrous structure in the shell of the latter.

Thin plates of the inner mother of pearl layer of *Margaritifera* and *Pinna* polarize brilliantly and give the lemniscate of a negative biaxial mineral with the axis at right angles to the layers, and so the mineral in all these cases is doubtless aragonite.

The smaller species of deep sea *Globigerina* show all this most beautifully and are a convenient object to demonstrate the stationary black cross and the higher order spectra in concentric rings. The silicious forms, Diatoms, Polycistina and sponge spicules do not polarize. This is true of the marine sponges like *Aspergillum* and *Euplectella,* but the freshwater sponge *Grantia* from the ponds around Amherst polarizes very strongly.

B. K. Emerson

Amherst, Mass.

THE TEACHING OF THE HISTORY OF SCIENCE

To the Editor of Science: In his interesting and valuable paper on "The Teaching of the History of Science" published in Science, November 26, 1915, Mr. Brasch calls attention to early courses in this subject which were given at the Massachusetts Institute of Technology, referring particularly as one of these to a reading course on the history of the physical sciences laid out as a requisite for graduation in the course in physics. The date which he mentions for its institution is 1887.

In fact, however, its beginning was much earlier. The writer from the outset of his work as a teacher had recognized the surprising lack of perspective existing among college students, but chiefly on account of the great pressure upon the teaching staff which existed here as everywhere, it was not possible at the time to institute a course of oral lectures upon the subject and the best that could be done was to lay out a suitable course of required reading, which was necessarily limited to physical science. This reading course was established at a considerably earlier date than that mentioned by Mr. Brasch, and is found set forth in the Catalogue of the Institute for 1880–81 in the scheme of studies leading to a degree in physics. A required reading course upon the logic of scientific investigation is also referred to in the same scheme.

A similar course on the history of the natural sciences is referred to in the same catalogue of the Institute in the scheme of the course in natural history.

C. R. Cross

SCIENTIFIC BOOKS

British Ants, Their Life-History and Classification. By H. St. J. K. Donisthorpe. Plymouth: Wm. Brendon & Son, Ltd., 1915. Pp. xv + 373, 18 pls. and 92 text-figs.

In this attractive volume we are given for the first time an exhaustive monograph of the ant-fauna of Great Britain, the result of many years of patient labor by one who served his biological apprenticeship as an ardent student of myrmecophiles. The volume serves also as a useful manual for the study of ants in general since it contains concise chapters on the anatomy, development and behavior of ants and the methods of keeping and studying

them in artificial nests. Naturally the greater portion of the work is devoted to a detailed account of each species known to be indigenous to Britain, under several heads, beginning with the original description, the synonymy, a good modern description and the geographical range, and ending with full ethological notes and a list of the myrmecophiles that have been taken in the nests of each form. The synonymy has been compiled with great care and from many old and obscure sources, often inaccessible to the American student. The work concludes with a list of species introduced into Britain, compiled in great part from scattered records of specimens taken in the hothouses of Kew Gardens and in dwellings, lumber yards, etc., in other parts of the islands. Among these introduced ants are a few dangerous pests, notably the Argentine ant (*Iridomyrmex humilis*), which was found "in vast numbers in a house in Windsor Park, Belfast, in 1900, where it had been observed for eighteen months," and in the Botanic Gardens of Edinburgh in 1912, and *Pheidole megacephala,* which in many tropical regions completely destroys all insects in its environment, except the Coccids, and disseminates and attends these to the great injury of many kinds of cultivated plants.

One is surprised to find the indigenous ant-fauna of Great Britain so meager compared with that of continental Europe. Only 40 forms are recorded by Donisthorpe, comprising 28 species, 14 subspecies (often ranked as species) and 8 varieties, representing only about one third of the central European fauna. Switzerland, a much smaller area than Great Britain and one which has been very carefully explored by Forel, has 116 indigenous Formicidæ, comprising 63 species, 17 subspecies and 36 varieties. The British fauna not only lacks any species peculiar to itself, but is also deficient in a whole series of genera and subgenera known to occur in Central Europe (*Strongylognathus, Harpagoxenus, Temnothorax, Neomyrma, Crematogaster, Pheidole, Messor, Aphænogaster, Dolichoderus, Bothriomyrmex, Plagiolepis, Polyergus, Camponotus* and *Colobopsis*). Most surprising is the absence of any species of the great cosmopolitan genus *Camponotus* in Great Britain. The carpenter ant (*C. herculeanus*), which is common throughout the northern portions of North American and Eurasia, could hardly be expected to be absent, but Donisthorpe shows that all records of its indigenous occurrence in Great Britain are very dubious. Some of the continental genera such as *Strongylognathus, Harpagoxenus, Bothriomyrmex* and *Polyergus* are rare and parasitic and it is very doubtful whether they will ever be found in the British Isles. Nevertheless, the singular parasitic *Anergates atratulus* was not discovered there till 1912, when it was taken by Crawley and Donisthorpe in New Forest, Hants.

Donisthorpe does not consider the interesting questions suggested by the relations of the British to the continental ant faunas, especially the reasons for the depauperate condition of the former, for not only are there few species in Britain, but these are represented by comparatively few colonies and therefore individuals. Insular ant-faunas in nearly all parts of the world are small, either because many islands are of too recent geological origin to have received many species by immigration (*e. g.,* Cuba and other West Indian Islands), or because their original Mesozoic or early Tertiary faunas have been greatly depleted or entirely obliterated by glaciation. Thus Iceland is entirely destitute of ants, and the ant-faunas of Great Britain and New Zealand are undoubtedly the meager survivors of glaciation. But when we consider that both of these regions have mild, temperate climates and an abundant vegetation, we find it more difficult to understand why the small number of surviving species is not represented by a great number of individuals, especially when we remember that Australia, North Africa and North America, which are, at least in part, much more arid and may have more severe, continental winters, nevertheless, have abundant ant-faunas. A consideration of such facts seems to indicate that moist, cloudy, cool temperate climates are very unfavorable to ants and that this may account for the meager

development of individuals in Great Britain and New Zealand. Even on continents we may notice the same dearth of ants in cool, humid regions, as, *e. g.*, in the Selkirk Mountains of British Columbia as compared with the Rockies of Alberta. The former mountains, which are very humid and covered with a rich vegetation, have a much poorer ant fauna than the latter, which are drier and have a more meager flora, though sufficiently moist and warm to afford optimum conditions for ants during the summer months.

In addition to a great amount of taxonomic and purely descriptive material Donisthorpe's book contains many original observations on the behavior of ants, especially in the sections devoted to the species of *Lasius* (notably *L. fuliginosus* and *umbratus*) and the blood-red slavemaker (*Formica sanguinea*). The illustrations are excellent and abundant and, with few exceptions, have been specially prepared for the volume. Most interesting are the figures of the gynandromorphs and ergatandromorphs of *Formica rufibarbis, F. sanguinea* and *Myrmica scabrinodis* (Pl. IV. and Figs. 45 and 46) and of the mrymithogyne of *Lasius flavus* (Fig. 47).

The only matter open to criticism in the volume is, perhaps, Donisthorpe's too hasty adoption of the generic name *Donisthorpea* for *Lasius*. The genus *Lasius* was based by Fabricius in 1804 on *Formica nigra* L., the common garden ant, one of the most abundant insects of the northern hemisphere, and since that date universally known, both in technical and popular literature, as *Lasius niger*. In 1914 Morice and Durrant exhumed a paper by Jurine published in 1801, in which the name *Lasius* was assigned to a genus of bees. The authors therefore renamed the ant-genus *Donisthorpea*. It seems, however, that there is serious doubt concerning the status of Jurine's paper, so that we need not be in a hurry to make this deplorable change in our nomenclature. At any rate, it will probably be difficult to persuade the majority of living myrmecologists, including Forel, Emery and the reviewer, to substitute *Donisthorpea nigra* for *Lasius niger*, a name which for more than a century has been almost as much of a household term as *Musca domestica, Equus caballus* and *Canis familiaris*.

W. M. Wheeler

SPECIAL ARTICLES

THE IMPORTANCE OF BACTERIUM BULGARICUS GROUP IN ENSILAGE

This department has been investigating the microbial flora of different kinds of ensilage at various stages of fermentation throughout the past year. The presence of *Bacterium Bulgaricus* group was first observed from the preliminary examinations of miscellaneous samples of ensilage. Since that time several hundred bacteriological analyses have been made from different kinds of ensilage, and at all stages of fermentation. The results obtained offer sufficient evidence to indicate the importance of this *Bulgarian* group in the ripening of normal ensilage. In a review of the literature relating to microorganisms of ensilage, only one reference[1] could be found which mentions the presence of *Bacterium Bulgaricus* group. The reference in question cites ensilage, along with many other substances, only as a source from which *Bacterium Bulgaricus* has been isolated.

Plate cultures, made upon acidulated glucose agar, were used for the cultivation of this group. The acid (1 cc. of a 1 per cent. sterile acetic acid solution) was added directly to the plates and mixed with the glucose agar when the latter was poured into the plates. The cultures were incubated at 35°C. for four days. The media permitted the growth of practically only two groups of microorganisms; the "*acid group*" and *yeasts*. The colonies of the latter were always few in number, if present at all, and with a little practise could be easily differentiated from the *Bulgarian* group.

The *Bulgarian* colonies showed varying degrees of size and form. In size, the colonies appear as very minute forms scarcely visible to the naked eye, to a type as large as the average lactic acid colony, and often larger.

In form, the characteristic "woolly edge" colony was frequent, but the predominating type was very similar to the common *Bac-*

[1] "A Study of *B. Bulgaricus*," P. G. Heinemann and M. Hifferan, *Jour. Inf. Diseases*, Vol. 6, No. 3, June 12, 1909.

terium lactis acidi colony. This type was either lance-shaped or a small round dense colony with uniform edges. A zone of cloudiness encircling the colony was characteristic of this form. The colonies of this group were also often observed and isolated from plain agar plate cultures.

The fact that the colonies of these organisms are very similar in many respects to those of *Bacterium lactis acidi* is probably one reason why this group has been overlooked by other investigators.

Much difference was likewise noted in the morphological features of the different cultures isolated, as well as in the same culture. In size, the organisms vary from small oval rods to well defined rods and filaments.

Detailed studies of many kinds of ensilage were made from the time the material entered the silo and at frequent intervals until ensilage was formed. The following kinds of ensilage were examined: cane, kaffir, cane fodder, alfalfa, and several kinds of ensilage made from the mixture of alfalfa and different carbohydrate materials. In every case the *Bulgarian* organisms were present in sufficient numbers to be very influential in silage fermentation.

TABLE I

Action of Bulgarian Cultures in Plain and Peptone Milk

(Temperature Incubation 35° C.)

(Figures give No. c.c. of N/20 NaOH to neutralize 5 c.c. milk.)

Cultures	After 5 Days		After 10 Days		After 15 Days		After 20 Days		After 25 Days		After 30 Days	
	Plain Milk	Peptone Milk	Plain Milk	Peptone Milk	Plain Milk	Peptone Milk	Plain Milk	Peptone Milk	Plain Milk	Peptone Milk	Plain Milk	Peptone Milk
65S	5.1	11.4	5.5	12.7	8.0	17.0	8.2	17.2	9.0	20.1	11.4	20.1
2X	4.8	11.4	5.1	12.9	6.1	13.1	5.0	12.5	5.7	13.3	11.6	15.5
44S	5.5	11.1	4.6	12.7	8.7	14.5	9.8	15.8	12.7	16.2	12.0	17.8
8S	6.6	6.0	4.0	4.8	5.3	5.8	3.7	5.7	3.7	7.0	4.0	7.7
9S	7.6	6.0	4.0	6.1	6.9	8.2	6.0	9.1	7.5	9.2	9.6	9.5
66S	9.2	13.2	9.2	14.7	12.8	19.3	11.6	19.5	15.3	19.5	15.3	24.4
70	5.8	11.4	5.0	12.8	8.1	14.5	8.3	16.2	11.3	17.6	13.0	19.0
14B	6.4	9.8	5.5	12.3	8.3	16.2	9.2	16.6	11.5	16.5	11.8	20.4
90S	6.3	13.4	7.3	15.1	9.2	16.3	9.7	16.0	11.7	17.3	12.7	19.0
96	7.2	14.3	8.3	13.5	10.8	14.4	10.8	13.9	12.9	16.9	15.5	18.0
CK*	3.5	4.1	3.5	4.1	3.5	4.1	3.5	4.1	3.5	4.1	3.5	4.1

*Check.

On glucose agar slants, the organisms grow very well. The characteristic growth is beaded to effuse in appearance. Glucose appears to favor the growth of the group. A good growth is observed in one to four days in glucose broth inoculated directly from a colony, while on the other hand, a litmus milk culture from a similar origin is coagulated only after two to fourteen days' incubation. Peptone added to the milk favors their growth; coagulation and acid production being much more prompt. The acidity produced by the different organisms in milk varies from 0.9 per cent. to 2.5 per cent., calculated as lactic acid.

The rate and amount of acidity produced from a few cultures, growing in plain and in 1 per cent. peptone milk respectively is shown in Table I.

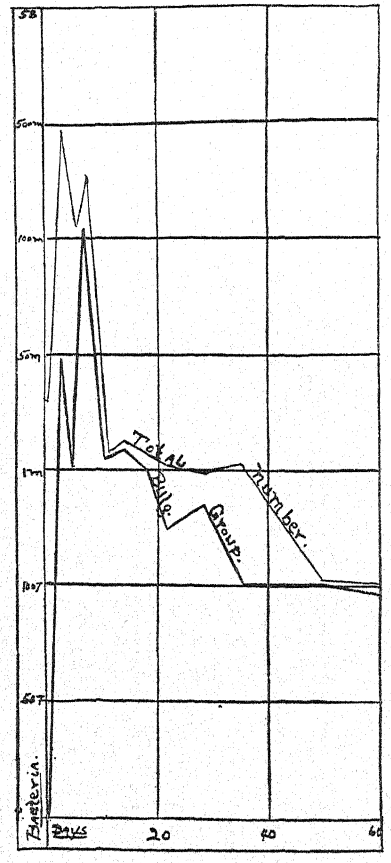
In Fig. 1 may be found curves plotted from the data obtained from kaffir silage. The table is self explanatory, showing the relation of the total *Bulgarian* organisms to the total microbial content throughout the ripening process of the ensilage. The ensilage was considered very good. The acidity[2] as it entered the silo was 0.18 per cent., figured as lactic acid. The final acidity was 2.07 per cent., of which 1.36 per cent. was non-volatile.

[2] The total acidity was determined by the method proposed by Swanson, Calvin and Hungerford, *Journal of the American Chemical Society*, Vol. XXXV., No. 4, April, 1913.

calculated as lactic acid, while 0.71 per cent. was volatile[3], figured as acetic acid. Plain agar was used to obtain the total microbial content. The relation of these two curves to each other compares very favorably with the corresponding curves made from other kinds of ensilage studied.

Fig. 1.

A Comparison of Total Numbers with the Bulgarian Type in Kaffir Ensilage



The presence of this group, in all normal ensilage, in large numbers, at a very important stage of fermentation, together with the fact that their characteristic fermentation is acid production, seem to offer sufficient evidence to support the view that a large part of the acid formed in normal ensilage is the result of their activities.

A more detailed report relating to silage fermentation will appear later.

[3] The volatile acids were determined by the method proposed by Dox and Neidig, *Research Bulletin*, No. 7, Experiment Station, Iowa State College.

O. W. Hunter
L. D. Bushnell
Department of Bacteriology,
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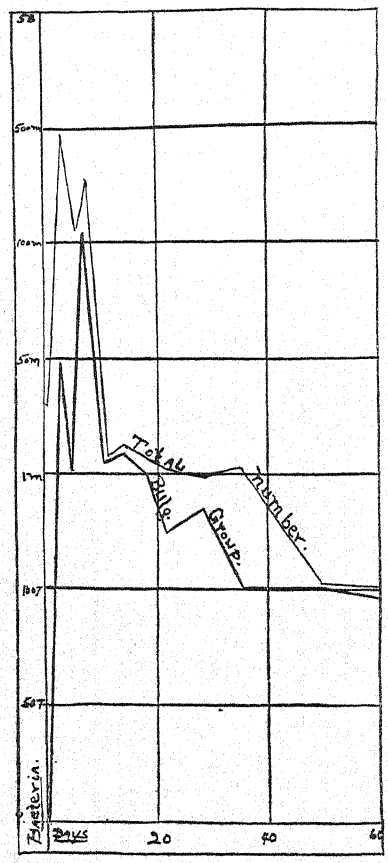

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''The Propagation of Transverse Waves in a Bar,'' by Louis Thompson.

''The Exceptions to the Law of Dulong and Petit,'' by J. E. Siebel.

''Experiments with Slow Positive Rays,'' by A. G. Dempster.

''Theory of the Free Vibrations of a Lecher System,'' by F. C. Blake.

''Springs of Minimum Weight,'' by Henry C. Lord. (By title.)

''Spectra of Some Halogen Compounds and Phenomena Connected Therewith,'' by Charles Sheard and C. S. Morris.

''On a New Method of using the Reversible Pendulum for the Determination of g,'' by J. C. Shedd.

''The Effect of Absorbed Gases in Photoelectric Emission,'' by Robert J. Piersol. (Read by E. P. Lewis.)

At the special session in charge of Section B on Wednesday afternoon the following program was presented:

''The Dependence of Progress in Science upon the Development of Instruments'' (Vice-presidential address before Section B), by Anthony Zeleny.

''A General Survey of the Field of High Pressure,'' by P. W. Bridgman. Discussion by A. G. Webster.

The Northrup Visible Molecules Apparatus was demonstrated at the close of the session.

At a short business session on Wednesday the result of the mail ballot for officers for 1916 was announced as follows: for president, R. A. Millikan, of Chicago; vice-president, H. A. Bumstead, of New Haven; secretary, A. D. Cole, of Columbus; treasurer, J. S. Ames, of Baltimore; members of council, Irving Langmuir, of Schenectady and G. B. Pegram, of New York; members of editorial board, A. Trowbridge, E. P. Lewis and W. C. Sabine. Several other items of business were transacted.

The registration for the meeting was 158. About one hundred were present at the Physicists' dinner on Wednesday evening. Whether judged by the number and character of the papers presented, by the attendance or by the amount and interest of the discussion following the papers, this meeting was one of the best that the American Physical Society has ever held.

A. D. Cole,
Secretary

THE BOTANICAL SOCIETY OF AMERICA. II

The Evolution of Reproductive Mechanisms in Seed Plants: E. C. Jeffrey and R. E. Torrey.

Mechanisms strictly so called are not numerous in plants. Among them may be classed the annulus which causes the opening of the sporangium in ferns and fern allies, including the cycads. The annulus is obviously a structure of epidermal origin, sometimes showing the presence of stomata. In the seed plants from *Ginkgo* upwards the opening mechanism of sporangia is not primarily of this nature. In the lower Gymnosperms the cryptogamic wood of centripetal development persists strongly, clearly indicating their filiation with the fern series. In the higher Gymnosperms the centripetal or cryptogamic wood becomes merged in the so-called transfusion tissue. The purpose of the present communication is to make clear that the transfusion tissue of *Ginkgo* and the Abietineae obviously furnishes the mechanism for opening the microsporangium. In the higher Conifers as well as in the Gnetales and angiosperms the fiber layer or mechanical system of the anther wall is no longer related to the fibrovascular system. The considerations advanced make it clear that sporangial mechanisms are of diverse origins. In the Cycadales and their allies the fern-like plants, the epidermis supplies the mechanically active layer. From the Ginkgoales upwards the tissues of the fibrovascular system, particularly the vestiges of the cryptogamic centripetal wood known as transfusion tissue, take on the function of providing for the opening of the spore sacks. The sporangium of the lower forms may appropriately be designated ectokinetic since its action depends upon the mechanical action of an external tissue, the epidermis. The sporangium of the higher forms, in which the fibrovascular tissue is primitively related to the mechanically active layer, is appropriately designated endokinetic.

The Comparative Rapidity of Evolution in Various Plant Types: Edmund W. Sinnott.

Given an equal degree of heritable variability, the rapidity with which a plant undergoes evolutionary change depends on the growth-type to which it conforms. Herbs, with their very brief period from seed to seed, accumulate changes much more quickly than do trees and shrubs, with their much longer generations. Local specific and generic types therefore arise most readily among herbs. Herbs occur in a much smaller number of

families than do woody plants, but their number of species per family is greater. A study of the rapidity of evolution in these two types throws light on the antiquity of the angiosperms.

Experimental Evolutionary Investigations with the Genus Drimys: E. C. JEFFREY AND R. D. COLE.

The genus *Drimys* of the Magnoliaceae has long excited interest as a dicotyledon entirely without the vessels, which are such characteristic features of wood structure in the angiosperms as a group. The value of experimental work in connection with evolutionary problems has been particularly emphasized in recent years and there can be no doubt that experimental studies on the part of those who are sufficiently acquainted with the history and morphology of plants to interpret the meaning of the structures experimentally produced, is of great value. Experimental investigation has in the past few years thrown great light upon the evolutionary history of the conifers and has begun to be applied to the elucidation of the course of evolution to the dicotyledons. The present communication is for the purpose of calling attention to the highly interesting fact that structures resembling vessels can be recalled in *Drimys* as a result of experimental procedure. It has not yet been found possible to bring about the return of such structures in the stem, but vessels are readily recalled in that most conservative of all plant organs, the root. The experimentally recalled vascular structures resemble those found in the Magnoliaceae as a whole. The consequence of this demonstration is of considerable evolutionary importance on account of the primitive position often accorded to the Ranales and in particular to the Magnoliaceae. It seems clear that *Drimys* can no longer furnish an argument in favor of this view since the simplicity of wood structure, resembling that of the Conifers, is not primitive but clearly the result of reduction.

Is the Vesselless Secondary Xylem of Certain Angiosperms a Retention of Primitive Gymnosperm Structure? W. P. THOMPSON AND I. W. BAILEY.

Vessels are entirely absent in the xylem of *Tetracentron, Trochodendron* and *Drimys*. Vestiges of vessels do not occur in the root, seedling, young stem, petiole, traumatic tissue, and other regions that have been considered to be retentive of ancestral characters. The form, structure and arrangement of the tracheids of the xylem closely resemble those of gymnosperms, and there seems to be no valid reason for not considering the three genera primitive as far as their xylem structure is concerned. The wood-parenchyma is "diffuse" in *Tetracentron, Trochodendron* and *Drimys winteri*. In *D. colorata* and *D. axillaris* it shows transitions from diffuse to banded and terminal. The distribution of parenchyma in these three genera makes it seem very improbable that the "terminal parenchyma" of the Magnoliaceae originated through reduction from the "vasicentric" condition. There appears to be no reliable evidence to indicate that the Magnoliaceae and allied families are forms that have become highly specialized through "reduction" from advanced types of Angiosperms.

Some Observations upon the Secondary Xylems of Gymnosperms and Angiosperms: W. W. TUPPER AND I. W. BAILEY.

From measurements of tracheid-lengths and wood-fiber-lengths taken from the secondary xylems of a large number of gymnospermous and angiospermous woods, respectively, the authors have confirmed and supplemented the work of Sanio, De Bary, Record and others, which show a very great difference between the lengths of gymnospermous tracheids, on the one hand, and the tracheids and wood-fibers of the dicotyledons, on the other.

The former elements average more than twice as long as do those of the dicotyledons of about the same age, with the very striking exception of the vesselless angiosperms, *Tetracentron, Trochodendron* and *Drimys*, which seem to have the typical gymnospermous length of wood elements.

Climaxes and Climates of Western North America: FREDERICK E. CLEMENTS.

Each climax vegetation is regarded as a developmental unit, and hence is designated as a formation. The vegetation of the continent is consequently made up of a number of climax formations, each with a development and structure more or less peculiar to itself. As a result, it becomes desirable to distinguish two kinds of units, developmental and climax, the one typical of succession, the other of the final adult condition of vegetation during a particular climatic period. Each climax is coextensive with its climate, and is in fact the indicator of the latter. Climaxes, moreover, exhibit a phylogenetic sequence due to differentiation and shifting in the face of a climatic crisis, such as glaciation. Such a shifting is recorded in the zones, such as are characteristic of

the Rocky Mountains, where five formations occur, namely plains grassland, woodland, montane forest, subalpine forest and alpine grassland. Finally, while each climax is more or less stable during a climatic period, the transition between two climaxes bears eloquent testimony to the shiftings of dominants and subdominants produced by minor climatic cycles.

A Photometer Battery for Habitat Analysis: F. E. Clements.

A series of photometers has been devised for the comprehensive study of the intensity and quality of light in the various kinds of habitats. Those used to measure light intensity are based upon the Bunsen-Roscoe photographic method. The simple photometer is designed for use on reconnoissance trips or in connection with a base station. Its most desirable form is the stop-watch photometer in which the personal factor in timing is eliminated. It is further modified into the water photometer for securing light readings at various levels in ponds and lakes. The recording photometer or selagraph consists essentially of a clock mechanism and a photographic shutter, permitting hourly exposures for a week without attention. The electric spectro-photometer is a compact instrument for determining the light quality in forest and thicket or at different altitudes, without the use of a tripod.

What is Tolerance of Forest Trees? George P. Burns.

The Root Growth of Forest Trees: W. B. McDougall.

Direct observations were made on the roots of *Acer saccharinum, Tilia americana, Carya alba* and *Quercus macrocarpa,* nearly every week during the growing season and occasionally during the winter, from April, 1914, to September, 1915.

Growth begins in April, the exact time varying with the season. It ceases in autumn or early winter when the soil becomes too cold for absorption. In 1914 there was a resting period of about five weeks in July and August when no root growth occurred. During this time the soil was very dry. In 1915 there was no dry season and no resting period. No attempt has been made to determine accurately at what temperature growth ceases or how much soil moisture is necessary for growth, but it is believed that enough has been done to establish the following general facts: (1) The root growth of forest trees begins as early in spring as the soil becomes warm enough for absorption, and ceases in autumn when the soil becomes too cold. (2) There is not necessarily a summer resting period. (3) When there is a summer resting period it is due to a lowering of the water supply, and not to any inherent tendency toward periodicity.

The Marine Algae of Beaufort, N. C., and Adjacent Regions: W. D. Hoyt.

Contrary to the belief that the Atlantic coast from Long Island to Florida is barren of Algae, 138 species and varieties have been found, all except 10 of these occurring at Beaufort. Of the total number, 130 have been obtained in sufficient amount for determination. There are represented 83 genera and 34 families, including all four divisions of Algae. The identified species are distributed as follows: Myxophyceae, 10, 7.7 per cent.; Chlorophyceae, 25, 19.2 per cent.; Phaeophyceae, 27, 20.8 per cent.; Rhodophyceae, 68, 52.3 per cent. Because of its intermediate position, Beaufort has an algal flora of unusual interest, 20 genera and 41 species reaching here their northern known limit on our coast, while 3 genera and 9 species reach here their southern known limit. Eighteen species new to North America have been found, 8 of these being hitherto undescribed. The seasonal differences are strongly marked in the flora of Beaufort harbor, only 12 species having been found throughout the year and 4 others in both spring and summer. The appearance and disappearance of the seasonal floras are strikingly coordinated with the observed temperature of the water. Measurements of the light show that this penetrates to very slight depths. Correlated with this fact, the algae seldom extend to a depth greater than 90 cm. below the low tide line. With the exception of a very few species, no Algae are found in summer above the low-tide mark. Several submerged coral reefs lying offshore offer extremely interesting conditions and a very interesting flora resembling that of subtropical regions.

Endemism in the Flora of the Vicinity of New York: Norman Taylor.

Endemism, as found in the flora of the vicinity of New York, does not appear to be a criterion of antiquity, for many endemics are very recent. Neither are the endemics prevailingly woody, for only 4 woody forms out of a total endemic element of 22 species disproves this contention. Nor does antiquity or woodiness prevail among the species of endemic genera. Rarity or commonness does not

appear to have much to do with the age of our local endemics, for it has been shown that some of our most widely spread species are among the newest in point of origin. "Relict endemism" accounts for 5 of the local species which are shown to be outpost survivals of a preexisting flora. All of these are species of endemic genera; only one is woody, although these are probably the most ancient of all our endemics. Generic and specific instability seems to account for the great majority of our endemics, 14 in all. These species are all shown to belong to genera that dwindle, or to be related to species that are on or near their limits, in the local region. Further support of this view is given by the proportion of species in eastern North American genera containing endemics, to the number of species found in the rest of the country and abroad. Only 20 per cent. of our whole vegetation finds its limits in the area, but much over half of our total endemics belong to genera that dwindle, or are related to species that find their limits, here or very near here. "Habitat endemism," where a species seems to have been thrust off from a well-known and widely dispersed form, into a totally different habitat from that of the supposed progenitor, seems to account for two of our local endemics.

On the Occurrence of Pinus Banksiana Lamb. in the Driftless Area of Southeastern Minnesota: C. O. ROSENDAHL AND F. K. BUTTERS.

The main pine forests of Minnesota occur to the north of a line drawn from the northwestern corner of the state to the Wisconsin boundary, about latitude 45° 30′. *Pinus Strobus* L. is found in a number of isolated localities down through the Mississippi River valley to northern Iowa, but outposts of *Pinus Banksiana* are very unusual. In June, 1915, a grove of jack pine was found near Rushford in the Root River valley, near the southeastern corner of the state. This is about one hundred and eighty miles south of the previously known limit in this state and at least eighty miles from the pine areas of central Wisconsin. It lies inside the driftless area and the indications are that it is a natural relict, probably from glacial times. The largest trees are estimated to be from fifty to sixty-five years old, thus dating back a few years beyond the oldest settlement of the region. Associated with the pines are a number of species which occur typically in the jack pine forests. Among those noted the following appear to be of special significance: *Oryzopsis pungens* (Torr.) Hitchc., *Carex siccata* Dewey, and *Vaccinium pennsylvanicum* Lam. The grove is located on a very sandy, steep, north-facing hillside which is built up from disintegrating paleozoic sandstones.

The Distribution of Quercus alba L. in the State of Minnesota: F. K. BUTTERS AND C. O. ROSENDAHL.

The white oak, *Quercus alba* L., occurs in southeastern Minnesota, extending to a point about thirty-five miles northwest of Minneapolis and somewhat farther due north of that city. It is local in its distribution, but where it occurs it is often very abundant. The explanation is that, at least in the climate of Minnesota, it is exacting as to its soil requirements and flourishes only on well-drained, non-calcareous soils which are moderately retentive of moisture. Such soils are the residual clays of the unglaciated region, the less calcareous portions of the loess, and the sour red clays frequently found in that part of the Wisconsin glacial drift which came from the northeast, and on all these soils the white oak abounds. The gray glacial clays from the northwest which underlie the main deciduous forest region of central Minnesota are generally too calcareous for this species, and it has succeeded in penetrating that region for only a few miles and in a few favorable localities. Near the middle of the state are some tracts of red clay similar to those which occur farther south and east, but no white oak has reached them, its place being taken by a form of *Quercus macrocarpa* Michx. It is suggested that the region of calcareous clays has acted as a sieve or selective barrier, allowing one of these species to migrate freely while greatly retarding the progress of the other. Culture experiments support the evidence derived from the distribution of the species. In four years, a seedling white oak grown in fine clean quartz sand grew about four times as large as a seedling of the same species planted in sand containing five per cent. of chalk, while bur oak seedlings grew almost equally well in the two soils.

The Patanas of Ceylon: H. A. GLEASON.

The patanas, or natural grasslands of Ceylon, occupy extensive areas in the southern end of the island, mostly at high elevations. They are usually located in valleys among the mountains, and at their upper margin come in contact with the subalpine forests. They occupy various types of soil, and receive various amounts of rainfall, depending on their location in reference to the mountain

ranges. The boundary between the patanas and the adjoining forests is remarkably sharp. The origin of the patanas is obscure, but their perpetuation is due entirely to the fires which sweep over them annually. Near plantations where the fires are excluded, a thicket association, characterized by *Rhododendron arboreum* and *Hypericum mysorense*, develops immediately, and is followed by the regular subalpine forest.

Observations on the Revegetation of the Katmai District of Alaska: Robert F. Griggs.

Under the auspices of the National Geographic Society the author has undertaken the investigation of the return of vegetation to the country devastated by the eruption of Mt. Katmai in 1912. Where the deposit of ash did not exceed one foot in depth, as, for example, at Kodiak, vegetation has made a most surprising recovery so that the grass and berries for which the district is famous, are finer than ever before. The new growth, however, is made up exclusively of surviving plants. Where for any reason the original plants did not persist the ground is nearly always as bare as when the ash first fell. Except in sheltered situations the ash is picked up by the wind, giving rise to a severe sand blast and forming great dunes which give little opportunity for the start of new seedlings. In more sheltered situations seedlings have started, but as yet form no important element in the vegetation, for their growth is very slow. Near the volcano the deposits were deeper; almost all vegetation was destroyed, leaving the country a bare desert. But some of the herbage persisted in sheltered nooks where the ash was quickly washed off the surface before the plants were suffocated. Such oases are, however, entirely insignificant in the barren landscape. Except for sporadic accidental instances, revegetation has not yet begun on the mainland.

The Cactus Columns of the Bad Lands: Raymond J. Pool.

Few cases are on record of cactus species serving as soil binders in opposition to the erosive forces of the environment. It appears that the root systems of cactuses are mostly characterized by the presence of shallow but more or less extensively spreading horizontal roots. Such plants are ordinarily rather easily uprooted. However, several instances have been noted in the Bad Lands of northwestern Nebraska of certain species of *Opuntia* which have a root system considerably deeper and less widely spreading than most cactus species. Furthermore, cushions or colonies of this species resist erosion to a surprising degree. The soil surrounding such cushions has been weathered away, leaving erect columns of the soil capped by the closely aggregated cushions or colonies of the cactus. These columns are sometimes more than ten feet high and vary in diameter from two feet to ten feet.

Modern Changes in the Prairie Groves of Iowa: B. Shimek.

It is often asserted that since the cessation of prairie fires the groves in the prairie region, including Iowa, have extended beyond their earlier limits. So far as Iowa, at least, is concerned, this is disproved by the testimony of old settlers, but especially by the records of the original government surveys. Several specific cases are presented in detail and illustrated by maps. The condition of the prairie groves is discussed with special reference to changes of an ecological character which are taking place and in which fire has played an unimportant part. The most marked change which is noticed is the increased density of both forest and undergrowth in the undisturbed groves. Incidentally this weakens or destroys one of the strongest supports of the view that fires caused the treelessness of the prairies. The results achieved in artificial tree-planting are also discussed.

Illustrating the Prickly Pears and Their Allies: David Griffiths.

In connection with the investigation of cactus conducted by the U. S. Department of Agriculture, distinguishing records of the species and varieties handled soon became imperative. In a group whose vegetative characters have in the past been relied upon mainly for taxonomic purposes, the task of distinguishing and depicting accurately the species dealt with in field tests and breeding investigations has been decidedly difficult. Some years ago it was decided to illustrate the species as accurately as possible. A living collection of 2,400 numbers of *Opuntia* has been accumulated at Chico, California. These are grown under field and sash house conditions and at present form the basis of the work. Characteristic portions of the plants, *i. e.*, old and young joints, flowers, buds and fruits are photographed to scale. Where the objects are large and the details complicated, as in the case of the joints, these photographs are used as a base for the water-color painting. In the case of fruits and buds, especially, they are outlined by the use of a camera lucida adapted to macroscopic work. Every effort is made to pre-

pare illustrations which are scientifically accurate. The cameras attend to the facts of form and Mr. L. C. C. Krieger, who has had varied experience and training in plant illustrating, attends to the remainder of the work about as successfully.

Relation of Catalase and Oxidase to Respiration in Potato Tubers: CHAS. O. APPLEMAN.

Respiration in potato tubers is not only greatly accelerated by various artificial treatments, but is subject to fluctuations under natural conditions, such as greening and sprouting. The rate of respiration varies in different parts of the same tuber and tubers of different varieties. The modification of the intensity of respiration in tubers under such conditions was determined and at the same time measurements were made of both the oxidase and catalase activity in the juice. The data seem to justify the following conclusions: (1) The oxidase content in potato juice gives no indication of the intensity of respiration in the tubers. In other words, there is no correlation between oxidase activity and the rate of respiration in these organs. The author does not disclaim any rôle of the demonstrable oxidases in respiration, but they certainly are not the controlling factor in regulating the rate of respiration in potato tubers. (2) Catalase activity in the potato juice shows a very striking correlation with respiratory activity in the tubers.

Lipolytic Action in Germinating Teliospores of Gymnosporangium juniperi-virginianae: G. H. COONS.

Teliospores from mature telial horns of *Gymnosporangium juniperi-virginianae,* were ground with fine sand and a small amount of water extract obtained. This extract when mixed with some neutral fat (olive oil, castor oil) colored violet by litmus, caused no change in color even after standing over night. When columns in which the spores were germinated were similarly ground and an extract of approximately the same amount obtained, this was found to produce acid from neutral fats. Reddening of the litmus which could readily be detected by comparison took place in two to four hours. In these experiments chloroform was used as an antiseptic. The experiments were repeated with changes in the technique. Telial horns were cut from several large galls. These were divided into three portions. One portion was left dry, the second was placed in water at approximately 80° C. to kill the teliospores, while the third was soaked in tepid water until the jelly-like telial columns were swollen. The water in which the third portion was soaked was then poured over the heated sori. This was an attempt to balance the bacterial and fungal flora of these two portions. The second and third portions were then drained and kept under similar moist conditions until the next morning. The columns were then ground with a small amount of water and a few cubic centimeters of water extract obtained. Tests were made with neutral fats colored violet with litmus. The third portion was the only one to give an extract which had the power to produce acid from the fats. In these tests small test tubes kept in the incubator at 37½° C. were used. Potassium cyanide was used as an antiseptic. When the active extract was boiled for a few moments it gave a negative result in acid production. The amounts of extract obtained were so small that no attempt was made to precipitate with alcohol. When oil which had been acted upon by the extract from the germinated teliospores was tested, glycerin was found to be present. None was found in the oil untreated. The conclusion seems justified that in germinating teliospores, lipase is present. This places the rust fungi in the long list of organisms now known to possess lipase. Attention may be called to the rôle of lipase in germination. The rust spores are especially rich in oils and in the short period required for germination one or more basidia, larger than the spore itself, are sent out. In addition two or more spores are formed on the basidium. The conversion of the globules of oil into soluble products easy of transport, seems to be a factor in this rapid germination process.

The Action Upon Soil Nitrogen of Certain Crops: K. F. KELLERMAN AND R. C. WRIGHT.

Twelve representative field crops were grown alone and in certain combinations in large galvanized iron buckets holding 100 pounds of soil. When two species of plants were grown in association, one half the number of plants of each species was used as when each was grown separately. Crops were all grown to maturity and harvested close to the surface of the soil. With the growth of millet, corn, Kafir corn and oats, practically all the total nitrogen removed from the soil was recovered in the crop. With wheat, barley, rye and sugar beets, all the nitrogen removed from the soil was not recovered in the crop. Also when hairy vetch, red clover and field peas were grown there was a distinct loss of nitrogen. With the growth of soy beans alone of the legumes, there

was a fixation or increase in nitrogen over that removed from the soil. When grown in association there was a loss of total nitrogen with the following combinations: barley and peas, rye and vetch, rye and peas, rye and clover, Kafir corn and peas, Kafir corn and clover, corn and millet, and corn and oats. There was an increase in nitrogen with the following combinations: barley and vetch, barley and clover, oats and vetch, oats and peas, oats and clover and Kafir corn and vetch.

The quantities of nitrate nitrogen remaining in the soil were comparatively low after harvesting millet, corn, Kafir corn and beets; and somewhat higher after clover, vetch, soy beans and peas; and still somewhat higher after oats, wheat, barley and rye.

A Physiological Study of Certain Strains of Fusarium oxysporum and Fusarium trichothecioides in their Causal Relation to Tuber-rot and Wilt of Solanum tuberosum: Geo. K. K. Link.

Certain strains of *Fusarium oxysporum* and *Fusarium trichothecioides* can produce both tuber-rot and wilt of the Irish potato. The wilt is induced by destruction of the root system and by clogging of the xylem elements in the stem and is, in mild cases, marked by such symptoms as discoloration of leaves, curling and rolling of leaves, and production of aerial tubers. Under field and storage conditions *Fusarium oxysporum* is probably more responsible for wilt than is *Fusarium tricothecioides,* and *Fusarium trichothecioides* the more responsible for tuber-rotting. This may be explained in part by the fact that the optimum and maximum temperatures of *Fusarium oxysporum* are higher than those of *Fusarium trichothecioides. Fusarium trichothecioides,* however grows well at 8°–10° C., while *Fusarium oxysporum* does not. *Fusarium oxysporum* also has a more rapid, superficial and spreading habit of growth than has *Fusarium trichothecioides.* Both organisms possess a truly striking cosmopolitan ability to use the most diverse carbon materials as carbon sources in their metabolism. *Fusarium oxysporum,* however, is more cosmopolitan in its ability, and can utilize materials more readily than, though not so completely as, does *Fusarium trichothecioides. Fusarium oxysporum* also is less subject to inhibition in growth and intoxication than is *Fusarium trichothecioides.*

Some Factors Determining the Presence of Fat as a Food Reserve in Woody Plants: Edmund W. Sinnott.

Reserve fat occurs most abundantly in those woods where the rays and parenchyma cells are comparatively thin-walled and well provided with pits, and is particularly well developed in the cells immediately adjacent to the vessels. It is practically absent in species with thick-walled, slightly pitted parenchymatous tissue. These facts suggest that the occurrence of fat in wood and its distribution there may depend on the ease of diffusion of some fat-forming ferment from the vessels through the rays and parenchyma. Experiment shows the presence of a fat-splitting ferment in the leaves and bark, which varies greatly in amount according to species and season, but which is in general most abundant in the spring in those species where reserve fat was most abundant in winter. It is suggested that perhaps this fat-splitting ferment (lipase) may here be reversible in its action and that during the late summer and fall it may be diffused downward through the wood and bast, converting into fat the food reserves to which it has access.

The Influence of the Medium upon the Orientation of Primary Roots: Richard M. Holman.

In this paper were considered the explanations offered by Hofmeister, Sachs, Elfving and Nemeč for the difference in behavior of primary roots growing in air and in earth when displaced from the normal perpendicular position. The author's experiment indicates that the failure of roots in air to bend downward after the autotropic flattening of the primary geotropic curvature is not due to absence of contact stimulus as Sachs suggested, nor to a change in the geotonus of the root as Nemeč's results seem to indicate. By the use of media whose resistance to penetration by the root tip could be widely varied, roots were caused to behave very nearly as in air or in the same manner as in earth, according as the medium was loose or considerably compressed. The authors' experiments indicate that the effect of the medium is primarily if not exclusively mechanical. The resistance offered by the medium to the advance of the downward curved tip of a root which has flattened its primary curvature tends to passively depress the root and in this manner the root is enabled to complete the geotropic reaction in media which offer appreciable resistance to the advance of the tip. *Vicia faba, Lupinus albus* and *Pisum sativum* were the principal species employed, although many other forms behaved similarly. Secondary roots of the three species men-

tioned behaved in a manner similar to the primary roots, reacting more promptly in media offering considerable resistance to penetration than in looser media. In the case of secondary roots the lack of complete permanent georeaction in moist air, as contrasted with prompt and complete curvature in earth, seems to be due to the mechanical cause mentioned above in connection with primary roots.

On the Permeability of Certain Non-living Plant Membranes to Water: F. E. DENNY.

A report of a series of experiments with plant membranes in which quantitative measurements were made of their permeability to water. Membranes used were seed coats of peanut, cycad, almond, English walnut, pumpkin, bulb-scale of onion, etc. Measurements were made in an osmometer so constructed as to detect the passage through the membrane of very small quantities of water, and to keep the physical factors such as temperature and concentration of solution constant. In each test the exact area of membrane used was known. Results are reported showing the temperature coefficient for a rise of 10° C., and showing the permeability of the membranes as affected by the concentration of the bathing medium, direction of flow through membrane, and as influenced by certain chemical constituents of the membrane.

Influence of Temperature on the Moisture Intake of Seeds: CHARLES A. SHULL.

A critical analysis of the data obtained as to the rate of moisture intake by seeds possessing semipermeable coats (*Xanthium*) at various temperatures from 5 degrees to 50 degrees C. shows that the curve of intake is by no means so simple as was assumed by Brown and Worley for barley seeds. The curves of intake are essentially the same in character in certain seeds used, whether semipermeable coats are present or not, but differ in steepness according to the kind of seed used. The temperature coefficient for the rate of intake is decidedly lower than the Van't Hoff coefficient for chemical processes, and considerably lower than the values obtained with barley seeds. Moreover, plotting the logarithms of hourly rate of intake against temperatures does not yield straight lines. It is evident, therefore, that the conclusions reached by Brown and Worley are not applicable generally.

Some Experiments on Galvanotropism: C. H. FARR. (Introduced by R. A. HARPER.)

The Structure of the Bordered Pits of Conifers and Its Bearing upon the Tension Hypothesis of the Ascent of Sap in Plants: I. W. BAILEY.

The tension hypothesis of the ascent of sap in plants, as interpreted by Dixon, postulates continuous columns of water that are entirely free from bubbles (0.02 mm. or more in diameter) of air or gas. However, even if continuous columns of water are present throughout the year, which has not been demonstrated conclusively, it remains to be shown how high tensions can arise and be maintained in the tracheids of tall trees. The pit membranes of Conifers are not entire septa, and are not impervious to undissolved gases and solids, as has previously been supposed to be the case. They are porous or sieve-like in structure, and the surface tension of the sap, in the sieve-like pit membranes of various Conifers, is not sufficiently great to prevent the penetration of air or gas, under the tensile strains that are supposed, by Dixon, to occur in tall trees.

H. H. BARTLETT,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 546th meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, December 4, 1915, and called to order by President Bartsch at 8 P.M. with 55 persons present.

On recommendation of the council Dr. R. W. Shufeldt, Washington, D. C., and Arthur deC. Sowerby, Tien Tsin, were elected to active membership.

On recommendation of the council the following resolutions were read and adopted:

WHEREAS: Dr. George M. Sternberg, former Surgeon General of the U. S. Army, a distinguished worker in the biological sciences as applied to medicine, long time an active member of the Biological Society of Washington and its president during the years 1895 and 1896, has passed from this life, therefore be it

Resolved: That the Biological Society of Washington keenly regrets his death and offers its warmest sympathy to Mrs. Sternberg, and will always be grateful to his memory for the important part which he took in the affairs and discussions of the society and for the distinction which his eminent name adds to its list of past presidents.

Signed L. O. HOWARD,
FREDERICK V. COVILLE,
PAUL BARTSCH

Under the heading Brief Notes, Exhibition of Specimens: Dr. O. P. Hay exhibited the skull of a walrus from the southern Atlantic coast of the United States and called attention to other specimens of walrus from localities now far south of its present range. It was Dr. Hay's opinion that the walrus had followed the retreating ice sheet northward. Dr. L. O. Howard called attention to the cluster-fly (*Pollenia rudis*), an insect resembling the house-fly but collecting in houses in autumn and leaving a yellow stain when crushed. Its life history was unknown until recently a foreign entomologist has shown that the larvæ are parasitic in earthworms in France. Dr. Howard is having large numbers of earthworms examined for such larvæ, but so far without success. He hoped that any one finding any grub parasitic in earthworms would communicate with him.

The first paper of the regular program was by Dr. Charles H. T. Townsend, "Identification of the Stages in the Asexual Cycle of *Bartonella bacilliformis*, the Pathogenic Organism of Verruga, and their Bearing on the Etiology and Unity of the Disease." The author finds that the complete asexual cycle of *Bartonella* can be interpreted from the figures and descriptions published up to April, 1913, and prior to the inception of the verruga work of Dr. R. P. Strong of the Harvard School of Tropical Medicine, and his associates. The six identifiable stages in these figures and descriptions are as follows:

I. *Early schizonts*—Gastiaburú & Rebagliata, Sept., 1912, in liver and eruption-tissue (eruptive phase).

II. *Maturing schizonts*, III. *Early merozoites*, IV. *Elongated merozoites*—Mayer, Rocha-Lima & Werner, April, 1913, in vascular endothelial cells of eruption-tissue (eruptive phase).

V. *Immature gametes*—Darling, 1911, in blood (fever phase).

VI. *Mature gametes*—Barton, 1905, in blood (fever phase).

The second and last paper of the program was by A. A. Doolittle "The Mississippi River Dam at Keokuk, Ia.; Its Effect upon Biological Conditions, especially those of the Plankton." Mr. Doolittle said:

The Bureau of Fisheries has been examining the new conditions caused by damming the Mississippi River at Keokuk, Ia., to develop electric power. The level of Lake Cooper, as the impounded waters are called, reaches northward for 54 miles, and must be maintained between 34 and 40 feet above 0 of the river gauge at Keokuk. In the lower portion of the lake the gorge of the Des Moines Rapids and its tributaries are filled. In the middle portion much island and farm land with standing forests are inundated. Water Persicaria is becoming established here. In the upper portion levees protect the threatened farm lands, which are kept drained by pumping stations.

There are present the usual characteristics of a river-lake: increased regularity of water stages, decreased current, decreased turbidity, establishment of aquatic plants. The most obvious and immediate effects, biologically, are, destruction of the famous mussels of the rapids, and interference with the migration of fish. Plankton is greatly increased; zooplankton in the Entomostracan species *Moina micrura, Diaphanosoma brachyura* and *Cyclops viridis,* phytoplankton species in *Converva, Anabaena, Clathrocystis.* Above the influence of the dam 50 Emtomostracan individuals, more or less, were present per cu. yd. throughout the summer. At Keokuk there were 1,500 in July, 270,000 in August, and 1,500 in early September, averaging about 10,000 per cu. cm. Green Algae was present in traces in the river proper; at Keokuk 0.14 cu. cm. in July, 29 cu. cm. in August, and 5 cu. cm. in early September. Blue Green Algae increased from traces in July to 2.6 cu. cm. in August and September at Keokuk. The river below the dam was enriched upwards of 100 times in mid-season. In weedy waters heavy bodied Entomostraca abounded; *Sida Scapholeberis, Simocephalus,* with a maximum of 178,000 individuals per cu. yd. whose volume was 23 cu. cm. Streams and sloughs filled from the lake ripened earlier than the lake, and maintained about 50,000 lake species of Entomostraca per cu. yd. Self-fed tributaries usually had plankton differing from that of the lake, sometimes Protozoa (*Euglena*) dominant, or Rotifers (*Asplanchna*), or their own Entomostracan forms. These could be traced into the lake, but they did not persist there. It is evident that there is a vast increase of fundamental food for some species of fish or their young. The discussion was illustrated with map, diagrams and slides showing conditions existing in the summer of 1914.

The paper was discussed by the chair, and by Messrs. Coker, Marsh and William Palmer.

The society adjourned at 10.10 P.M.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

FRIDAY, MARCH 10, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE SCOPE AND RELATIONS OF TAXONOMIC BOTANY[1]

IN his famous work, "Philosophia Botanica," Linnæus, in accord with his fondness for system in all things, classifies the authors that have dealt with botany and allied subjects. He first divides botanical writers into two groups, true botanists, and botanophils or lovers of botany. The botanists are again divided and subdivided with much detail into numerous groups. The botanophils consist of four groups, the anatomists, the gardeners, the writers upon medicine, and lastly a miscellaneous group including those who write upon plants from the standpoint of economics, panegyrics, theology or poetry. It is clear from this classification that among those who concerned themselves with plants the systematic botanists held the dominating position. They were the real botanists, the others were only botanophils. Among the latter were the few anatomists and physiologists such as Malpighi, Grew and Hales. It is true that Linnæus has, as a subdivision under the true botanists, the heading physiologists, but he defines these as those who reveal the laws of vegetable growth and the mystery of sex in plants. This disposition of the physiologists was no doubt influenced by Linnæus's own interest in sexuality in plants. In this connection it should be noted that the great classifier places Hales, the physiologist, among the botanophils and not among the botanists. For a century more the botanical

[1] Address of the retiring president of the Botanical Society of America, Columbus, December 29, 1915.

field was dominated by the taxonomist. But at this time taxonomy meant for the most part only the study of the species of the flowering plants. During the nineteenth century other branches of botanical science asserted themselves and began to compete with taxonomy for supremacy. Toward the end of the century taxonomy not only lost its dominance, but in this country at least was relegated to an inferior place. At present the pendulum indicating the trend of botanical thought has swung far away from the position occupied during the days of Linnæus, Hooker, Torrey and Gray. Taxonomic botany in the conventional sense is almost taboo. There is a feeling abroad among botanists that systematic botany is old-fashioned and that to be a taxonomist is to be behind the times. At most of our institutions of learning taxonomic botany as such is not taught at all or is relegated to a minor position. At the meetings of our botanical societies the percentage of papers dealing with taxonomy is disproportionately low. In a recent number of the *Plant World* it was stated that out of the 45 doctorates in botany conferred by American universities in 1915, two were taxonomic. The same disproportion prevails in most of our journals and periodicals devoted to the whole field of botanical science. It is difficult also to obtain properly trained young men for positions in taxonomic botany.

Let us examine the causes that underlie these conditions, first, the dominating position of systematic botany during the eighteenth and early part of the nineteenth centuries, and second, the gradual loss of prestige since the middle of the last century and the inferior position in botanical thought now occupied by systematic botany as represented by the classification of species.

The botany of the seventeenth century consisted almost entirely of the enumeration of the known species of plants. Up to this time, the chief interest in plants, leaving out of consideration of course the crop plants, had been their use in medicine. From the practical standpoint it became necessary to record the known species and to describe their uses. These records are preserved in those massive tomes generally classed as herbals.

As the number of known species increased, attempts at classification were made, crude at first but reaching an advanced stage in the eminently practical sexual system introduced by Linnæus. There was early a reaching out for a natural system of classification. Even Linnæus, the creator of the sexual system, tells us in his famous text-book, cited above, that a natural classification is diligently to be sought, that plants show affinities on all sides like a territory in a geographical map.[2] He then proposes 63 groups of flowering plants and four others to include the ferns, mosses, algæ and fungi. The first work to use a natural system on a large scale was Decandolle's "Systema,"[3] the first volume of which was issued in 1818. The natural system soon displaced the Linnæan system.

The years from 1790 to 1850 were an era of botanical exploration. Thousands of plants from all quarters of the globe poured into the centers of botanical research. There was much work for every botanist who was capable of distinguishing and describing species. Every collection received

[2] *Phil. Bot.*, 27, 1751. "Methodi naturalis fragmenta studiose inquirenda sunt. Primum et ultimum hoc in botanicis desideratum est. Natura non facit saltus. Plantæ omnes utrinque affinitatem monstrant, uti territorium in mappa geographica. Fragmenta, quæ ego proposui, hæc sunt."

[3] Decandolle, A. P., "Regni vegetabilis systema naturale," 1, 1818; 2, 1821.

from exploring expeditions yielded scores or even hundreds of new species. Is it to be wondered at that taxonomy held a dominating position in botanical research and that most of the great botanists of the period were taxonomists? At the beginning of this period modern chemistry and physics were in their infancy and the compound microscope had not yet been perfected. It is easy to see why it was that well along into the nineteenth century botany was considered to be chiefly the description and classification of species. Furthermore, botanists were working upon the hypothesis of created species, not upon that of the evolution of species.

Let us turn back for a moment to note the growth of experimental science. Of science as we understand it there was little in the middle ages. Instead was authority. Arguments were settled, not by direct test, but by consulting the statements of the Fathers. Tradition hampered the development of all branches of human research, especially of the sciences. The statements of Aristotle were for ages considered infallible. That the root of the mandrake cried with pain when torn from the earth and that the fruit of the goose tree developed into bird or fish according as it fell upon the land or in the water, was accepted without question. Here and there a courageous soul by questioning tradition created much disturbance and brought upon himself the revilings or at least the reproaches of the powerful. Slowly at first, more rapidly during the latter part of the eighteenth century, grew the tendency to test theories by experiment, to verify facts. Great minds were attracted to the field of scientific research. There was a certainty about the relation between cause and effect that was vastly satisfying to the intellectually alert. The discovery of oxygen by Priestly in 1774 gave an impetus to chemistry. Upon the foundation of facts accumulated up to about the time that Davy decomposed potash in 1808, Dalton was able to present a theory of the construction of matter, the atomic theory, which to a remarkable degree has answered up to the present time the requirements of a working hypothesis even though modified by recent discoveries. Faraday, the great experimenter, somewhat later laid the foundation for the extraordinary development in the domain of electro-magnetics. The microscope was greatly improved, opening up a wide field of research concerning the internal structure of plants. During the nineteenth century there was much interest in plant anatomy, in the development of the cryptogams, and finally in plant physiology. A growing proportion of botanists devoted their attention to these or allied branches. The theory of the special creation of species was superseded by that of the evolution of species. As the experimental method was widened in its application to the various fields of botanical research, the science of botany became increasingly attractive to intellectual workers. But in this increased interest and activity descriptive taxonomy has not retained its share. At the beginning of the nineteenth century nine tenths of the prominent botanists were engaged in the discrimination of species. At the beginning of the twentieth century probably not one tenth are thus engaged. This reversal of proportion is due in part to the widening field of botany. Still I think that there is at present in descriptive taxonomy an evident lack of interest that is not entirely explained by this widening of the field of botanical research.

What are the reasons for this lack of interest in what is conventionally known as systematic botany? Some botanists, especially of the younger generation, have be-

littled descriptive taxonomy because this seemed the popular thing to do, having received the impression that taxonomy was old-fashioned. Some, also of the younger generation, have come little in contact with the subject during their period of training, hence consider it a very special line which is rather a side issue compared with such subjects as morphology and physiology. Some have felt that a career in systematic botany offered little in the way of reputation or of financial return, and so have entered more promising fields.

Another reason for the somewhat suspicious attitude assumed by some botanists toward taxonomy is the prominent part assigned during the last twenty-five years to nomenclature. The creditable desire to place nomenclature upon a sound basis has resulted in many changes in familiar names. Such changes have been embarrassing to morphologists and physiologists who look with disfavor on changes in terminology except in their own branches. Furthermore there have been auxiliaries who have taken advantage of the unsettled condition of nomenclature to substitute the study of names for the study of plants.

These reasons, however, are inconseqential. They would deter no one imbued with the scientific spirit. Is not the fact that there has been no satisfactory way of applying the experimental method to the discrimination of species the real reason why descriptive taxonomy has been avoided by so many botanists? In chemistry and physics the relation between cause and effect can be tested and results can be foretold. In recent years the same method, answering questions by direct test, has been applied in many branches of botany. But in taxonomy one has no definite test by which results can be proved. One may put in years of hard work and seem to get nowhere. You will remember how Charles Darwin struggled with the classification of barnacles and Asa Gray with asters. I thoroughly sympathize with them, as will every botanist who has attempted a serious study of the classification of a difficult group of plants. We work over them for months, patiently noting differences and resemblances, assembling and segregating, seeming to have a scheme nicely worked out, only to have it upset by a new batch of specimens, going through all the stages of hopefulness, satisfaction, doubt, hopelessness, and finally tearing our hair and exclaiming "Confound the things! What's the matter with them, anyway?" This kind of work does not appeal to the average scientist. He prefers to wrench facts from nature by frontal attack, by applying the experimental method. He wants to do something under controlled conditions and see the result, having the assurance that under the same conditions he will always have the same result. To him this puttering over the differences of species is the veriest waste of time—that is, of his time. His attitude towards the classification of species is much like the attitude of descriptive taxonomists towards the classification of horticultural varieties. If the horticulturist classifies the hundreds of varieties of the apple by such characters as color, form, size, markings and time of ripening, the groups will merge into one another. The resulting classification can be used only by those who know the varieties; but if they know the varieties they do not need a classification by which to identify them. This is somewhat exaggerated, but it fairly well represents the way the classifier of species looks at the work of the classifier of horticultural varieties. And I think it represents the way the physiologist looks at the work of the taxonomist. This is not said in disparagement of the work of classifying horticultural varieties. It is given

only as an example of how such work suffers by being far removed from the field of experimental research.

The taxonomist arrives at results not by the application of the experimental method, but by the repetition of observations. To be sure the geneticists are applying the experimental method with considerable success, but their results can have no immediate bearing on the subject under discussion. Ascertaining facts by the method of repeated observations lacks the precision and definiteness of the experimental method. The examination of hundreds of herbarium specimens, plant mummies, is not so fascinating nor so satisfying as it is to set up a piece of apparatus and see something happen. I believe this is the chief reason why so many of our keenest minds have hesitated to join the ranks of the descriptive taxonomists, the results appearing to them indefinite in proportion to the time and energy spent in obtaining them.

Now let me review with you the scope of taxonomy in the broad sense, the science of classification. To me the two great questions that botanists seek to answer are, *how do plants live?* and *how are plants related?* Most botanical investigations can be used as an aid in answering one or the other of these questions. From this standpoint the two fundamental divisions of botany are physiology and taxonomy. Many facts in physiology may be established by experiment. Most facts in taxonomy are established by repeated observation. Various subsidiary branches of botany may aid one or the other of these fundamental divisions according as the facts obtained are used in answering the main question. Morphological studies gather certain facts which in themselves are interesting, but which reach their highest usefulness only when structural morphology yields to physiology and comparative morphology yields to taxonomy.

Taxonomy in the general sense is the science of classification. But the taxonomy with which we are concerned is that which attempts to answer the question, how are plants related. The very question implies that plants are related. Our taxonomy assumes the evolutionary hypothesis that all the organisms of the present day have developed or evolved from other somewhat different organisms of the past. The great truth which taxonomy is seeking to express is the genetic relation of organisms. If the genetic history of all organisms were known the classification of these organisms would be merely an arrangement of facts. But the genetic history of organisms is not known, or known only for an infinitesimal number for an infinitesimally short period of time. Our classification of plants is, then, an expression of judgment as to what are the probable genetic relations of these organisms. At the best this classification can represent only a cross section of the lines of phylogenetic development. It may be compared to a formula in calculus with a large number of variables. The value of the formula may be found for any given moment by substituting the values that the individual variables have at that same moment.

Some workers in this broad field of systematic botany are studying the relations of the more comprehensive subdivisions of plants such as the families, orders and groups higher than these. In such investigations they seek for resemblances, as it is these upon which, rather than upon differences, the interpretations of relationship must be based. Some botanists, on the other hand, are concerned chiefly with the determination of the relations of the ultimate systematic groups of organisms, the species and their subdivisions. Here the observer

is seeking differences, for the resemblances are plain to be seen.

Intermediate between the species and the family lie groups, such as the genus and the tribe, in which one must look for both differences and resemblances and strike a balance between them. The botanist who studies species, and hence looks for differences, compares the more superficial characters of plants, those that are most easily modified in the development of new forms. The botanist who studies the relation of orders and more comprehensive groups, is concerned chiefly with those characters which have resisted modification in the course of development. I have referred to the work of the former as descriptive taxonomy. The work of the latter is often included in the designation comparative morphology. It is to be regretted that there has been some lack of understanding between these two groups and a consequent lack of sympathy. A title such as "The Morphology of *Cycas* and *Welwitschia* and its Bearing on the Origin of the Gymnosperms" would attract one group as being an important paper in comparative morphology, while a title such as "Five Hundred New Species of *Rubus*" would be laid aside with the remark, "another species-maker broken loose." The one looks upon the other as a species-maker who knows little of the real problems of botany. The other looks upon the one as a section-cutter who knows plants only through the compound microscope. Both may be doing really good taxonomic work. This is determined, however, not by the fact that one is cutting sections and the other is describing species, but by the fact that each is using scientific methods and is dominated by the scientific spirit.

The ideal of the taxonomist is a scheme which shall represent the genetic relations of organisms. Each of us who are taxonomists is hoping to contribute his mite toward this harmonious whole. The lines of descent are real though unseen; they exist, but their position and direction can not be proved. As the astronomer studies the constitution and evolution of the universe, as the chemist studies the constitution and evolution of matter, so the taxonomist studies the constitution and evolution of organisms. One of us may be describing new species of *Rubus*, and showing their relation to previously known species. Another may be revising a genus of mosses and adjusting the relations of the species in the light of recently acquired knowledge. Another may be studying the comparative anatomy of seaweeds and with the observed facts attempting to solve the problem of relationship. Another may be studying the development of the spores of smuts and tracing, as it were, the prehistoric development of the group. Thus are anatomy, morphology, ontogeny, paleontology, yielding facts to taxonomy. Thus are we all uniting in the great effort to answer the fundamental question, how are plants related.

Considering the trend of botanical thought during the present decade, I need not ask the members of this society if comparative morphology is an interesting field of research. My predecessor and my successor are shining examples of those who have advanced the limits of our knowledge in this branch. But the domain of descriptive taxonomy, the elaboration of genera and species, is this an inviting field for the young botanist who is seeking an opportunity to take part in solving the problem of relationships?

For reasons already given this branch has been unpopular in recent years. Though descriptive taxonomy will never attract workers to the proportionate extent that it did before the rise of the experimental sciences, yet it will be found to satisfy the

cravings that are characteristic of the students of science. The mental satisfaction of the scientist who loves his work comes not alone from achievement, but from the actual doing.

There is the search for truth, the discovery of facts, the arrangement of the facts to represent relationships, the peering behind nature as she is to determine how she came to be what she is, the blending of all into a harmonious whole, the feeling that we are solving one of the fundamental problems of the universe. Our imagination bids us soar aloft in the realms of speculation, but our progress in these delightful journeys is ever limited by the chains of facts binding us to earth. We are victims of the inexorable law of compensation. We must pay the price for successful flights in this realm of speculation where we dream our dreams and build our theories. This price is the drudgery of slowly accumulating facts. We must work, work, work. We must examine thousands of specimens, both living and preserved, in herbarium, garden and field, just as the comparative morphologist must examine thousands of sections, staining, cutting, mounting. We must measure and weigh evidence, persistently, patiently, accurately. It is thus that we lengthen the chains binding us to earth and thereby soar higher and higher. Occasionally one of us is so exhilarated with the joy of soaring that he severs the chains of facts and rises unrestricted, but, alas, soon disappears from view. Some of us are so busy with our facts that we never have time for soaring. Only a few have that happy combination of industry and imagination that allows them to rise to great heights and yet remain within our view. These few have that rare ability to select related facts, to distinguish the essential from the non-essential, to separate the significant from the insignificant.

The laboratory of the descriptive taxonomist is three fold, the field, the herbarium and the garden. The facts concerning the plants that he studies can most satisfactorily be observed from living specimens in their native habitat, that is in the field. Apart from the practical impossibility of observing in the field all the plants that the worker may wish to study, there is the difficulty of comparing those that grow in different localities. This difficulty is in part overcome by bringing together in a herbarium preserved specimens. The disadvantage of studying herbarium specimens is that in the larger individuals only a part can be represented and that many characteristics of the living plant can not be shown. By far the most satisfactory method of studying plants from widely separated localities is to bring them together in a botanic garden where they may be preserved alive. It is almost hopeless to attempt the study from herbarium specimens alone of such groups as cactuses, palms, agaves, and bamboos. I can not let this occasion pass without emphasizing to you the importance to taxonomy of having a national botanic garden. Under the supervision of the federal government such a garden is likely to receive more ample support than one depending upon state, municipal, or private aid, and because of its national character is likely to extend its influence over a wider area.

There is another phase of descriptive taxonomy—an eminently practical one—which merits attention, namely, certain relations between this branch and all other branches of botany, relations which involve the use of the botanical names of plants. Taxonomy is the classification of organisms, but definite progress requires the use of names for the organisms classified. Names are older than systems of classifica-

tion. First there were vernacular names in the different languages. Then vernacular names in Latin acquired prominence because Latin early became the language of the books. Later we have the development of the idea of the genus with the corresponding application of the generic name, the kinds or species being distinguished by descriptive phrases. And finally Linnæus introduced the use of the trivial or, as it is now called, the specific name. Thus each species is designated by a binomial. You will readily see that plant names become, as it were, units of precision by which all branches of botany are standardized. From this standpoint taxonomy is fundamental because it furnishes the standard units of comparison and coordination, these units being not merely the names but the ideas which these names represent.

Botanists not always have been sufficiently impressed with the necessity of basing results upon carefully prepared standards. If a chemist wishes to determine acidity by titration he first prepares standard solutions of acid and alkali; or if he wishes to determine the atomic weight of zinc he first prepares pure zinc or zinc salt as a basis from which to work. If a surveyor wishes to cover a country by triangulation he first measures with extreme accuracy his base line. Results can not be compared unless they are based upon an accurate common standard. Suppose a chemist wishes to determine the solubility in water of sodium carbonate at different temperatures and to compare his results with those obtained by a chemist in another country. Suppose he is well trained, accurate in his methods, has balances weighing to a small fraction of a milligram, determines the solubility of his glass vessels, and the purity of his distilled water, and is able to calculate results within small limits of probable error. Then finally suppose that he bases all his careful work on a bag of washing soda obtained at a corner grocery. What would you think of him? Suppose an American botanist wishes to repeat the investigations made by an English botanist upon the anatomy of the stem of the day lily. Suppose that he is well trained, accurate in his methods, has the finest of microtomes, has at his command the last word on staining and methods of imbedding, supports his record with magnificent photomicrographs, and is a master of all the technique required. Suppose he is not acquainted with the day lily, but nevertheless trusts his untrained gardener to bring for his investigation a plant which the latter thinks probably is a day lily. What would you think of him? I have attempted to illustrate my point by exaggerated examples. I wish, however, to emphasize the statement that all comparative investigations upon plants depend for their usefulness upon accuracy in the identification of the species compared. Even competent and experienced botanists have sometimes neglected to establish at the beginning of an investigation this firm basis for work. The less experienced man is sometimes inclined to assume, especially if he has had limited training in taxonomy, that plants in gardens, greenhouses and herbaria belong to the species indicated by the labels they bear. Such faith is beautiful to behold, but, alas and alack! the worker is often a victim of misplaced confidence. The investigator should first establish the identity of the plant which he studies. If he has not had sufficient training in systematic botany to enable him to do this himself he should refer his specimen to a competent taxonomist and preferably to a specialist in the group to which the plant belongs. In comparing results based upon definite species of plants there arises

another uncertainty. Supposing that the second of two investigators whose results are to be compared, has based his work on correctly identified material, can it be assumed that the first investigator has taken equal pains to identify his material? Unfortunately this assumption may be without sufficient foundation. One must consider the probability of error. The paper recording results may show internal evidence of a satisfactory nature. The author may state the origin of his material or note the care taken in its identification, or that it was submitted to a specialist. Any such internal evidence increases confidence in the results. If the plants used by both investigators of this hypothetical pair have been accurately identified we may apply the mathematical axiom, things equal to the same thing are equal to each other. However, the probability of error is very greatly reduced if direct comparison can be made. This can be done only if each investigator has preserved the plants he has studied. This leads me to make this plea to botanists. Let every worker preserve the specimen he has studied if his results are in any way connected with the identity of the species. I think that anatomists, cytologists, morphologists, and others that study the internal structure of plants, are in the habit of preserving in alcohol or other liquid, the portion of the plant with which they have worked. Specimens of this kind should always be preserved in order that observations may be confirmed, but fragments, such as these are likely to be, are not usually sufficient for taxonomic identification. For the latter purpose a specimen should be prepared and placed in a public herbarium, accompanied by a label bearing the data necessary to connect the specimen with the investigation that it supports. If such supporting evidence is at hand any controversy as to the identity of the plants studied by different workers can be settled by consulting these herbarium specimens. The physiologist may find it to his advantage to follow the same procedure. His work is often with plant life in general rather than with particular species. But whenever his investigations concern definite species he should preserve herbarium specimens. The ecologists are fond of giving lists of plants growing under certain conditions and comparing these plants with those growing under similar conditions elsewhere. In the early days of this younger branch of botanical science little attention was paid to the identity of the species, and still less to preserving representative specimens. The subject was lightly waved aside with the assertion that they were not concerned with the identity of the individual species, only with the aspect of the vegetation. The modern school of ecologists, I am pleased to say, takes a more serious view of the rôle played by definite species. If it is worth while publishing a list of species at all, it is worth while supporting the record with permanent evidence. The geneticists, a young and active brood of investigators, will find it to their advantage also to adopt the method outlined above. The living specimens are the best of evidence while they exist, but at best they are evanescent. Herbarium specimens, if properly prepared and properly cared for afterwards, are permanent. If his plants have been passed upon by a general taxonomist or better by a group specialist the non-taxonomist may be deluded with the idea that his record is complete, that the identity of his species is beyond question and is fixed for ever and ever. Such an assumption depends upon the infallibility of taxonomists. I can assure you, however, that taxonomists are very fallible. Specialists may not agree among themselves on the identity of a

given plant, and the same specialist may not agree with himself on the identification of the same plant made at different times. This is not said to discredit the specialist. But specialists in taxonomy like specialists in other lines are not, even though specialists, masters of all the knowledge of the group of plants they study. Their opinions may change as their knowledge increases. Then let me repeat, the only safe way to support records when definite species are concerned is to preserve specimens and place them in a public herbarium.

The names of plants are the common language connecting all sciences and arts having any relation to botany. For a large part of the botanical public, consisting of agriculturists, horticulturists and many botanists, especially those who are not taxonomists, the usefulness of taxonomic work lies in the ease and certainty with which botanical names can be applied. To them names are convenient symbols by which plants are known. A change in the application of botanical names is as confusing as the change of a person's name. Consequently they look with concern and disfavor upon the seemingly kaleidoscopic changes undergone by the names of common plants. After the publication of the "Rochester Code" there was a rush to bring plant names in accord with this code. Some of this work was serious or at least sincere. Some was such as to leave the impression that the authors had in mind chiefly the publication of new combinations. The flood of new names appearing in lists, local floras and isolated notes, the work based upon a study of books rather than of plants, produced an unfavorable effect upon the standing of systematic botany. Those unfamiliar with the real scope and meaning of taxonomy hastily concluded that this branch of botany was for triflers, was not worthy of serious study, and was to be avoided.

But we should not be confused by superficialities. For example, an enthusiastic youth, wishing to climb the ladder of fame, makes a voluminous list of plants growing in swamp, in prairie and in forest, and inflicts upon the public, "The Ecology of Podunk." His brother, with an equally laudable purpose, delves in some musty volumes, consults the Index Kewensis, and emerges with a list of brand-new combinations, after each of which appears his own name as the authority. Let us not judge the scope of ecology by the incomplete efforts of the one, nor the scope of descriptive taxonomy by the misdirected efforts of the other.

Nomenclature is an essential detail in all taxonomic work. One should not hesitate to change a name if there is a necessity for a change. It has been said that a name is an expression of a taxonomic idea. Nothing should stand in the way of the most precise expression of correct taxonomic ideas. While it is desirable to conserve familiar names it is a poor policy to avoid change merely to conserve names. The objection, then, is not to the study of nomenclature as a detail in connection with monographic work, but to its study apart from the study of the organisms to which the nomenclature applies. There is even objection to work in which a superficial consideration of organisms is merely a series of pegs upon which to hang an elaborate study of nomenclature. Changes in names should be evidently a result of serious study of the group concerned.

The non-taxonomic public is constantly pleading with the taxonomists "to get together," to agree on a system of nomenclature which shall result in the stability of plant names. The taxonomists, I may say, are sometimes impelled to voice the same

sentiments in so far as concerns changes of names in groups of plants of which they have no special knowledge. Several attempts have been made to legislate upon the subject of nomenclature. It has been impossible thus far to frame a set of rules to which all botanists can agree. There are the rules of botanical nomenclature formulated at the International Botanical Congress held at Vienna in 1905. These rules are often referred to as the Vienna Code. To many competent botanists in both Europe and America these rules are so unsatisfactory that they will not subscribe to them. In this country many botanists have agreed upon a code, usually known as the American Code, which from the practical standpoint is more certain in its application. These two codes provide that our nomenclature shall begin with the year 1753, the date of the publication of the first edition of the "Species Plantarum" by Linnæus. There are still other botanists who would throw aside all limitations to the rule of priority and use the earliest names to be found in literature. Recently some one proposed a new name for the genus *Zizania* because *Zizania* of Linnæus, the swamp grass called wild rice, is not the same as *Zizanion* of the New Testament, which is the name of the weed the enemy came and sowed and which in our version is called "tares." It is not my purpose here to discuss these systems of nomenclature. I am only calling attention to the lack of unanimity on the subject among taxonomists. But suppose all taxonomists should agree upon a single system of nomenclature. Would this do away with the changes of names? By no means. In the first place it would take years to adapt the hundreds of thousands of names of plants to any code that might be adopted. But aside from these changes coincident with the search through countless books, pamphlets and ephemeral sheets, some very rare, some probably unknown to the present generation of botanists, aside from these changes due to the imperfections of our records, there are other changes resulting from the increase in our knowledge of plants. Stability in nomenclature is unattainable, just as stability or permanence in any branch of learning is unattainable so long as our knowledge concerning that branch is increasing. Codes of nomenclature enable botanists to make changes according to definite rules, they do not eliminate change. We shall have stability of nomenclature only when we have stability of taxonomic ideas, which latter will come only with infinite knowledge.

This society includes a large percentage of the botanists of this country, physiologists, morphologists, taxonomists, paleontologists, ecologists, cytologists, anatomists, geneticists, pathologists, but all botanists, and all contributing to the upbuilding of the science of botany. The society might be compared to a living organism, in which each botanist is performing a definite work contributing to the success of the society, even as each organ, or each cell, performs a definite function necessary or helpful to the life of the organism. By far the greater part of our work consists in accumulating details. As a successful army can not consist solely of generals, so a successful botanical society can not consist solely of philosophers. As the great general is one with an extended knowledge of the duties of his subordinates, so the true philosophical botanist must be intimately acquainted with much of the detail of the worker, the drudgery of small things.

When first we enter the realm of botanical research we long in the impatience of youth to make some great discovery, to reach at a single bound the heights to which others slowly toil. As we grow older we

realize that we must "build the ladder by which we rise." Each of us finds that he is but one of a vast army of patient plodders, seekers after truth. We become more and more willing to do that which is close at hand, to seize small opportunities as they pass, rather than waste time looking for the great opportunities of our dreams. Darwin was one of our great speculative philosophers, but his philosophy was founded upon an amazing array of facts, and his experience as an observer of details, especially that gained in his classic taxonomic investigation of the barnacles, contributed in no small degree to the soundness of his philosophical judgment.

Though the realm of botany, as a whole, is too great for any one individual to comprehend all its branches, and each must confine himself to one or two branches, the sympathy of each may and should extend to every branch. Finally, the ideal of taxonomy is the utilization of the results obtained by all the branches of botany; it is the expression of the sum of the knowledge to which all contribute; it is the philosophy of botany in that it correlates the parts into a harmonious and ever growing whole.

A. S. Hitchcock
U. S. Department of Agriculture

THE CENTIGRADE THERMOMETER

The Hon. Albert Johnson, member of Congress from the third district of the state of Washington, under date of January 12, addressed to members of the American Association for the Advancement of Science the letter which follows:

A reprint of my speech "Abolish the Fahrenheit Thermometer," dealing with Bill H. R. 528, introduced by me on December 6, 1915, is sent herewith to all members of the American Association for the Advancement of Science.

The speech is followed by extracts from letters, and I profit by this opportunity to express my sincere thanks to the writers of those letters for the valuable aid which they have rendered. I request that this acknowledgment be accepted in lieu of a personal reply, which I am reluctantly compelled to forego, owing to lack of time and clerical help.

The labor and expense involved in this undertaking will at best be considerable. Already the expense for printing exceeds $150. While every step should be taken with due deliberation, any unnecessary delay would involve a regrettable increase of labor and expense. If no action is taken at this session of congress, much of the work will have to be done over again at some other session. No man that has any regard for his reputation will care to say that the irrational, inconvenient Fahrenheit scale ought to be maintained; the only question is, how soon it should be abolished. An amendment lengthening the transition period to 8 or 10 or 15 years may be worth considering, but we should ill deserve our reputation as a progressive nation if we delayed to *set a date* for the abolition of a daily felt nuisance. As pointed out by several correspondents, it ought to have been done long ago. The change will necessarily be attended with considerable inconvenience, but this will not be lessened but increased by delay. We have already earned enough ridicule by clinging so long to the worst thermometric scale.

Every man in a responsible position now has a chance to gain credit by doing his best to facilitate the change. If any should feel tempted to advocate delay, they ought to consider that they would thereby gain not credit but discredit, because the change is sure to be made in the near future.

The Pan-American Scientific Congress has twice recommended "the establishment of the Pan-American Meteorological Service." Evidently the first requisite for that purpose is the abandonment of the Fahrenheit scale.

It appears that the government departments have authority, under existing law, to discontinue the use of the Fahrenheit scale. In publications designed for the scientific public, many bureaus do use the centigrade exclusively. However, as regards publications intended for the general public, it is evident that the departments would expose themselves to severe criticism if they made the change without an express mandate from congress. Congress evidently will not act except in response to an unmistakable demand on the part of the scientific public.

All progressive scientists, therefore, should unite to rid American science of this "iron shirt of

habit.'' By a resolute simultaneous effort at the first onset, when interest is fresh, we may avoid the necessity of spending ten times the amount of labor in wearisome and costly agitation. No earnest man should excuse himself on the plea that ''the others'' will push the bill through without his help. If every man took that attitude, there would be no ''others.''

At my request a committee, under the chairmanship of Dr. S. W. Stratton, Director of the Bureau of Standards, has been appointed by the American Association for the Advancement of Science to take charge of the bill. This committee, located at Washington, within easy reach of congress, will serve as the natural center of a nation-wide organization. All communications on the subject should hereafter be addressed to ''Thermometer Committee A. A. A. S., Bureau of Standards, Washington, D. C.''

It is recommended that local committees, as branches of a national organization, be formed in all the states, to bring the subject to the attention of the press and to secure the adoption of resolutions by scientific and educational organizations, faculties of universities, firms, corporations, etc. Copies of such resolutions—the briefer the better—should be sent to as many individual members of congress as possible.

The American Association for the Advancement of Science, with nearly 9,000 members, might itself be deemed fairly representative of the American scientific public. Nevertheless, in order to avoid the criticism that this measure was pushed through congress without adequate consultation of those concerned, I shall be glad to send this circular and the reprint of my speech to other societies, if their secretaries will express a wish to that effect. As the type is kept standing, it will be easy to order new editions as fast as the demand for them arises. By thus submitting the question, as nearly as possible, to a popular vote of all those who are competent to express an opinion, all semblance of arbitrary action may be avoided.

Meantime it is hoped that the present circular and accompanying speech will be reprinted and discussed as widely as possible in the scientific and popular press, so that any one who cares to raise objections may have a chance to do so. Clippings containing such printed discussions will be thankfully received by the above-named committee.

For the present you can render valuable aid by answering the questions on the enclosed question sheet and mailing it in the enclosed envelope, which requires no postage. Unless you express a wish to the contrary, it will be assumed that you permit the publication of your remarks entire or in extract.

The questions are as follows:

1. Should the use of the Fahrenheit scale be discontinued?

2. Can you suggest arguments in addition to those contained in the accompanying documents?

3. Can you suggest amendments to the bill? (Text of bill on page 3 of speech.)

4. What length of time should be allowed before the use of centigrade degrees, with or without the addition of the equivalent in Fahrenheit degrees, becomes obligatory in government publications?

5. What length of time should be allowed before the use of Fahrenheit degrees in parentheses after centigrade degrees is discontinued?

6. In case you were invited by the Committee on Coinage, Weights and Measures to state your opinion orally before them, would you be willing to come to Washington for that purpose?

7. Do you know of any organization that might be willing, on invitation by the committee, to send delegates to Washington for the same purpose?

8. Are you willing to work in behalf of this movement—by writing, lecturing, organizing state committees and other committees, securing resolutions from societies, faculties of universities, etc.?

9. Can you suggest other methods of work?

10. Can you give the names and addresses of secretaries of societies whose members ought to receive the circular and other documents?

SUMMER "ASSEMBLY IN SCIENCE" AT THE SCRIPPS INSTITUTION

THE experiment of holding a "Summer Assembly in Science" at the Scripps Institution for Biological Research at La Jolla, on the sea coast near San Diego, will be tried by the University of California this summer for the first time. The purpose is to disseminate among teachers of biology and physical geography and others interested in modern science the discoveries and new points of view which are resulting from the investigations of this research department of the university, and to

acquaint scientific men with the richly varied sea-life of the California coast.

There will be lectures, conferences and demonstrations every afternoon of the six weeks by members of the scientific staff of the institution on the following subjects (each once weekly). "The Relation of Biology to the Sciences of Man," Professor William E. Ritter, Fridays; "Heredity, Environment and Adaptation," Dr. F. V. Sumner, Thursdays; "Some of the Messages of Marine Biology to Student and Teacher," E. L. Michael, Wednesdays; "Physical Oceanography, Including Some of Its Relations to Meteorology," G. F. McEwen, Tuesdays. "Local Coastal Physical Geography" will be a course to be conducted Monday, Wednesday and Friday mornings, at 10 o'clock by W. C. Crandall, who as master of the *Alexander Agassiz,* the institution's seagoing scientific collecting vessel, has wide familiarity with the California coast. The rest of the mornings of every day except Saturday will be devoted to lectures, laboratory, museum and field work for small groups of students on the characteristic animal and plant life of the ocean waters along the shore of southern California, this work being conducted by W. C. Crandall and P. S. Barnhart.

The university has been encouraged in such undertakings by the success of the annual summer session at Berkeley (for next summer from June 26 to August 5), which last year enrolled 5,364 students.

Half a mile of ocean frontage, with cliffs, sand beaches and tide pools inhabited by a wide variety of sea-life is the ideal location which the Scripps Institution for Biological Research occupies, two miles north of La Jolla and fifteen miles north of the center of San Diego but within the corporate limits of the city. The "investors," as Miss Ellen B. Scripps and Mr. E. W. Scripps prefer to be known, have provided the Scripps Institution with maintenance funds and with a commodious laboratory building containing twelve private laboratories for investigators, a large aquarium room, a two-story concrete museum and library building, now in course of construction; and a concrete pier a thousand feet in length, at which the eighty-five foot collecting vessel, the *Alexander Agassiz,* can dock, and from the end of which, far out beyond the surf zone, pure sea water is pumped in to supply the nineteen tanks in the public aquarium and also the scientific laboratories. The institution possesses a biological library of over 5,000 bound volumes and 8,000 pamphlets and the principal scientific journals in its field, and a museum is being assembled of the marine fauna of the California coast.

"Endowed research in pure science is absolutely essential to continued progress in civilization"—such is the declaration of faith which Director William E. Ritter makes in his announcement of this assembly in science at La Jolla, from June 25 to August 5. "In a democratic country like ours," he continues, "there must be provision for investigation and also definite measures to disseminate the fruits of investigation as widely as possible among the people."

Any persons interested in science who wish to attend the assembly at the Scripps Institution are requested to write as soon as possible to Professor William E. Ritter, scientific director of the institution, at La Jolla, so that proper provision may be made.

THE CLOSING OF BRITISH MUSEUMS

A PROTEST against the closing of British museums (including art galleries) was made to the prime minister on February 10 by a deputation representing the Museums Association, the National Art Collections Fund, the Royal Asiatic Society, the Hellenic Society, the Art Workers' Guild and the Imperial Arts League. Mr. Asquith said that in addition to the reading room of the British Museum, the government had decided to keep open the National Gallery and the Victoria and Albert Museum. In view of the numerous colonial visitors and wounded soldiers who resorted to the Natural History Museum, a further concession might be made by keeping open the portions of the museum which most interest ordinary visitors. Sir E. Ray Lankester writes to the London *Times:*

I am afraid that our legislators are ignorant of

the contents and purposes of the museum, as well as misinformed in regard to the paltry amount really involved in admitting the public. That is more than probable since, when I was its director, I was frequently told by the eminent politicians and other public men—who had unfortunately been appointed trustees of the museum—that they had never visited its galleries, and really felt little interest in its contents. The action of those who desire to pose as economists in making a paltry saving by treating science with contempt can only be explained by their disastrous ignorance.

Lord Morley writes to the same journal in regard to the Natural History Museum:

The saving to be effected would be nearer £2,000 than £3,000 per annum. I need not dwell on the disadvantage to students; that is obvious. Then, as the Archbishop said, not at all too strongly, "there would be a great deal of disappointment to such institutions as convalescent homes in the neighborhood of the Natural History Museum, which had been largely visited by wounded officers and men." Besides these, London has a host of colonial visitors just now, and experience shows that the Natural History Museum is one of the places the best of them most desire to see. Interest in the Elgin Marbles at Bloomsbury may, if ministers like, be more or less of an acquired taste. Interest in and curiosity about the animals, birds, insects and all the other wonders in the collection at South Kensington are simple and natural and instructive. To shut your doors in face of curiosity and interest so general, wholesome, and enlivening as this, for the sake of a few hundred pounds in a budget counted by thousands of millions, seems a singular and not quite a diminutive example of perversity, even in our civilized world's present saturnalia of perversity.

SCIENTIFIC NOTES AND NEWS

THE Hébert Prize of the Paris Academy of Sciences has been awarded to Professor M. I. Pupin, of Columbia University, for his theoretical and experimental researches in electricity.

THE William H. Nichols medal will be presented to Dr. Claud S. Hudson at the meeting of the New York section of the American Chemical Society, on March 10. Dr. Hudson will make an address on "The Acetyl Derivatives of the Sugars."

DR. SIMON FLEXNER, director of the laboratories of the Rockefeller Institute for Medical Research, has been appointed Cutler lecturer at the Harvard Medical School for 1915–16.

DR. BRADLEY MOORE DAVIS, professor of botany at the University of Pennsylvania, has been elected a fellow of the American Academy of Arts and Sciences.

THE committee of the British Privy Council for Scientific and Industrial Research has appointed the Hon. Sir C. A. Parsons, K.C.B., F.R.S., to be a member of the advisory council in place of Professor B. Hopkinson, F.R.S., who has been forced to resign by the pressure of special work connected with the war. The committee has also appointed Professor J. F. Thorpe, F.R.S., to fill the vacancy on the advisory council caused by the death of Professor Raphael Meldola, F.R.S.

DR. HENRY K. BENSON, professor of industrial chemistry at the University of Washington, has been appointed director of the newly established Bureau of Industrial Research, the first such institution on the Pacific coast. One fellowship dealing with a problem of the iron and steel industry and amounting to $2,000 has already been established as a result of the cooperative spirit existing between the bureau and the business men of the Pacific northwest. Other fellowships are contemplated. Men interested in the by-products of the fisheries industries have also assigned one of their problems to the bureau for special investigation. The bureau will attempt to coordinate the research activities already undertaken by the university, with a view to the utilization of the resources of Washington.

DR. FREDERICK H. BLODGETT, since 1912 plant pathologist and physiologist at the Texas Agricultural Experiment Station, on January 1, assumed his duties as pathologist in the Extension Service of the Agricultural and Mechanical College of Texas. The increasing volume of correspondence and the need of definite information by field observations and demonstration projects on disease control will be met by this addition to the staff.

DR. ISADORE DYER, dean of the college of medicine of Tulane University, and an authority on leprosy, addressed the senate committee on February 17 in Washington on a national leprosorium.

PROFESSOR H. V. TARTAR, head of the Oregon Experiment Station department of chemistry, has been granted a two-year leave of absence to pursue research work at eastern universities.

AN expedition for the study of echinoderms and siphonophores, under the auspices of the department of marine biology of the Carnegie Institution of Washington, will leave New York for Tobago, British West Indies, on March 10. The investigators are Dr. Hubert Lyman Clark, of Harvard University; Professor Th. Mortensen, of Copenhagen, and Dr. Alfred G. Mayer. Professor E. Newton Harvey, of Princeton University, will visit Japan under the auspices of the same agency.

MR. H. U. HALL, leader of the University of Pennsylvania Museum's expedition to Siberia, has arrived in Philadelphia, after an absence of nearly two years. The expedition covered some hitherto unknown parts of Siberia and experienced a great number of hardships. Many collections of ethnological specimens have been brought home to the museum.

KNUD RASMUSSEN, the Danish explorer, proposes to sail on his next expedition from Copenhagen to Greenland, about April 1. The region he proposes to explore is the desolate country between Peary Land and Greenland, and to the north of Etah, where Donald B. MacMillan and his fellow-explorers are icebound for the present winter.

PROFESSOR S. J. BARNETT asks us to state that the $300 grant to him from the trustees of the Ohio State University was not made for work on the cause of the earth's magnetism, as reported, but for experiments on the magnetic effects of rotating nickel and cobalt.

AT the meeting of the New York Section of the American Chemical Society on March 10, Dr. Carl L. Alsberg, chief of the bureau of chemistry of the Department of Agriculture, made an address on "The Development of the Bureau of Chemistry."

BEFORE the Philosophical Society of Washington on March 4, the address was given by the retiring president, Dr. W. S. Eichelberger, on "The Distances of the Heavenly Bodies."

DR. CHARLES R. STOCKARD, professor of anatomy in the Cornell University Medical College, gave, on March 1, the second in a series of public lectures before the Yale Chapter of Sigma Xi. His subject was "Experimental Studies on the Influence of Alcohol in Development and Inheritance."

DR. GEORGE T. MOORE, director of the Missouri Botanical Garden, delivered recently an address before the Massachusetts Horticultural Society at Boston, on "The Missouri Botanical Garden."

THE next Harvey lecture at the New York Academy of Medicine will be given Saturday evening, March 11, by Professor Henry A. Christian, of Harvard University, on "Some Phases of the Nephritis Problem."

DR. LOUIS DUNCAN, of the consulting engineering firm of Duncan, Young and Company, New York City, distinguished for his work in applied electricity, associate professor of applied electricity at the Johns Hopkins University from 1887 to 1899, and head of the department of electrical engineering at the Massachusetts Institute of Technology from 1902 to 1904, has died in his fifty-fourth year.

CHARLES G. CARROLL, Ph.D. (Johns Hopkins), for the past eleven years head of the department of chemistry, University of Arkansas, died at Fayetteville, on February 23, of tubercular meningitis.

DR. HENRY BAIRD FAVILL, professor of clinical medicine in the Rush Medical College and professor of medicine in the Chicago Polyclinic, died from pneumonia on February 20, aged fifty-five years.

A. S. MARSH, who held a studentship in botany in Caius College, Cambridge, and had made valuable contributions to plant ecology, has been killed in the war.

DR. FRANCIS WYATT, of New York City, an authority on fermentation and brewing, has died at the age of sixty-one years.

PROFESSOR JOHAN CHRISTIAN MOBERG, of the University of Lund, the distinguished paleontologist and stratigrapher, died on December 30, 1915, at the age of sixty-one years.

NEWS has been sent us of the death of Alan Owston, naturalist and merchant, of Yokohama. Mr. Owston was born in England in 1853 and, while a boy, went to Yokohama, where he was engaged in a general export and import business. In connection with this, however, he undertook deep-sea dredging, fitting up different yachts, the best one being the *Golden Hind*, with which he made numerous explorations of the deep sea. Among other things, he discovered many new species of fishes. These have been described by Dr. Jordan and his associates, Dr. Gilbert and Professors Snyder and Starks, and by Dr. Tanaka, of the Imperial University of Tokyo. Part of his collections are in the National Museum and the British Museum, but the bulk of them has been purchased by the Carnegie Museum of Pittsburgh. In addition to his work as a naturalist and explorer of the deep sea, Dr. Owston took a very deep interest in the cause of national peace, writing under the pen name of "Asio," numerous articles in Japan in opposition to the war system. Recently he became one of the editors of a journal known as *Commercial Japan*.

MR. WARREN K. MOOREHEAD, of Andover, Massachusetts, is preparing a volume on Indian stone ornaments and problematical forms. He will be glad to receive communications from museum curators and those interested in technical study of prehistoric stone ornamental objects and the distribution of such forms. Mr. Moorehead will present a number of maps showing areas in which ornamental and problematical forms known as banner, winged and bird stones, charms and amulets, etc., are found. The relation of these to the distribution of linguistic stocks will be indicated.

THE President of the United States has issued a proclamation, dated February 11, stating that whereas, certain prehistoric aboriginal ruins situated upon public lands of the United States, within the Santa Fe National Forest, in the state of New Mexico, are of unusual ethnologic, scientific and educational interest, and it appears that the public interests would be promoted by reserving these relics of a vanished people, with as much land as may be necessary for their proper protection, therefore a national monument is established to be known as the Bandelier National Monument.

THE department of chemistry of the College of the City of New York announces special lectures to be given at 3 P.M., as follows:

March 10—"Food Control in New York City," by Mr. Lucius P. Brown, director, Bureau of Food and Drugs, Dept. of Health, New York City.

March 17—"The Extraction of Radium from Its Ores," by Dr. Chas. L. Parsons, mineral technologist, United States Bureau of Mines.

April 7—"Chemical Control of Medical Supplies Purchased for the United States Army," by Lieutenant D. W. Fetterolf, Medical Relief Corps, United States Army.

April 14—"Science in the Humanities," by Mr. Elwood Hendrick.

May 5—"The Emancipation of American Chemical Industries," by Dr. Thomas H. Norton, commercial agent, U. S. Department of Commerce.

May 12—"Food Poison," by Mr. James P. Atkinson, chemist, Food and Drug Laboratory, Department of Health, New York City.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Illinois has purchased for its school of pharmacy a new site located at the corner of Wood and Flournoy Streets, Chicago, immediately opposite the new Cook County Hospital, and affording a frontage of 201 feet on Wood Street and 128 feet on Flournoy Street. The purchase includes two substantial brick buildings erected for the Chicago Homeopathic Medical College and Hospital some years ago. These buildings will be put into shape at once, and it is expected that the school will remove to its new quarters

immediately following the close of the present school year. The new location is in the great medical center of Chicago and only a short distance from the medical and dental colleges of the university, which will bring its three Chicago departments into much closer relations.

An endowment of $50,000 to support graduate fellowships for Canadians in the American University, Washington, has been made by the estate of the late Hart A. Massey, of Toronto, who desired to establish, if possible, some link between the Methodism in Canada and the United States.

Mr. C. E. Probyn has bequeathed the residue of his estate, amounting to about £10,000, to the University of Bristol.

Nature quoting from the *Pioneer Mail* states that the staff has now been selected for the Lady Hardinge Medical College and Hospital at Delhi, which Lord Hardinge opened on February 17: Principal and professor of medicine, Dr. K. A. Platt; professor of anatomy and gynecology, Miss Hitton; professor of pathology, Miss Field; professor of anatomy, Miss Murphy; professor of chemistry, Miss A. M. Bane; professor of biology and physiology, Miss M. R. Holmer. It is expected that tuition will begin next September, and the government of India will contribute a lakh of rupees (about $33,500) yearly to the annual maintenance charges.

Dr. Roscoe Pound, Carter professor of jurisprudence, has been appointed dean of the Harvard Law School. Dr. Pound is known to scientific men for his studies of the phytogeography of Nebraska. He is a member of the Botanical Society of America and a fellow of the American Association for the Advancement of Science. Dr. Pound was a member of the Committee of the American Association of University Professors which drew up its Report on Academic Freedom and Academic Tenure.

Professor Eliot Blackwelder, of the University of Wisconsin, has been called to the headship of the department of geology at the University of Illinois.

DISCUSSION AND CORRESPONDENCE

CROWN GALL OF PLANTS AND CANCER

Recently I have made discoveries which tie crown gall of plants closer to cancer of man and animals. I can now produce embryonic teratomata at will by bacterial inoculations. All that is necessary is to inoculate growing plants in areas containing dormant totipotent or pluripotent cells, using *Bacterium tumefaciens*. Moreover, as in man, daughter tumors are produced freely and these also contain teratoid elements. These results have been obtained repeatedly during the last two months on *Pelargonium*, tomato, tobacco and citrus. A full account will be published within a short time.

Erwin F. Smith

Washington, D. C.,
March 3, 1916

THE RISE OF SEA LEVEL SHOWN BY COASTAL DUNES

In a paper[1] published in the second annual report of the state geologist of Florida, in 1909, the writer called attention to sand dunes on the coast of southern Florida and the relation of these dunes to present sea level. It is altogether possible that others have noted the value of the evidence shown by coastal dunes as indicating changes of sea level with respect to the land, but the writer has not seen any references to the matter, and for that reason mentions it again.

Dunes may be divided into two classes—active and quiescent. Active dunes are those that are still growing, fed by supplies of wind-blown sand from some nearby expanse. Quiescent dunes are not growing, and are covered with vegetation. A good example of an active coastal dune is the great dune at Cape Henry, Va. Good examples of quiescent dunes may be found at many points along the Atlantic coast.

At some quiescent dunes close to the shore the writer has observed that a dune, as shown by its shape and the stratification of its sands, grew under conditions that no longer exist,

[1] Sanford, Samuel, "Topography and Geology of Southern Florida," page 184.

there being now a swamp to windward; also, as in Florida, there may be outlying keys, or, as at many places, beach ridges, the keys or beach ridges being higher than the swamp and consequently higher than the old beach or sandy expanse from which the dune grew.

Evidently, such quiescent dunes furnish positive evidence of a rise of sea level. Also, it is clear that this change of sea level must be of Recent or of latest Pleistocene age, the position of the dividing line between Pleistocene and Recent time being necessarily a matter of opinion, for the dunes can not be old. Even those of Florida, which indicate a rise of sea level of at least five or six feet at their bases, rest on late Pleistocene marls and limestone. The exact age of the dunes and the exact length of time that has elapsed since they became quiescent by the growth of swamps cutting off supplies of sand, are alike indeterminable, but the sharpness of characteristic outlines and the size of the trees on many of them indicate quiescence for hundreds, but not for thousands of years.

A locality where this relation between swamp growth and dune quiescence may be conveniently observed by many persons is at Ventnor, N. J., on Absecon Island, south of Atlantic City.

It is believed that the evidence of the dunes mentioned confirms that of shore-lines, beach ridges, and coastal swamps, namely, that the Atlantic coast of the United States has subsided, or the sea level has risen, in Recent time, and that the change of sea level is probably still in progress.

Evidently, also, termination or interruption of growth by a near-by rise of water level is not restricted to dunes along the sea shore, but applies to all dunes.

S. SANFORD

WASHINGTON, D. C.,
December 20, 1915

A REPUTED SPECIFIC FOR BLACKWATER FEVER

I HAVE in my herbarium two curious plants from the interior of Venezuela, which are of special interest because of their chemical properties. They were collected and presented to me by Dr. Jesus Maria Piñango at Guanoco, Venezuela.

The first specimen is used by the natives of eastern Venezuela as a specific for the dreaded blackwater fever. The plant grows in swamps and reaches a height of six feet. It bears ovate, opposite, entire leaves, tapering to a long point. When boiled to use for fever it colors the water rose-pink.

I should like to invite any reader of SCIENCE who is an expert in therapeutics, and would be interested to analyze and test the properties of this plant to communicate with me, and I will gladly send a specimen for this purpose. For if this plant really possesses the medicinal properties ascribed to it, it might be of much value in the treatment of the blackwater fever, which is so fatal in parts of Venezuela and still more prevalent and deadly in tropical Africa.

The other specimen is a very powerful narcotic. It is called by the Guarauno Indians *Charapu*; and is used by them for poisoning fish in the following manner. A quantity of the leaves are gathered and pounded down into a small hole in the ground so as to form a ball. This is then dried. On going fishing in a river or stream, one man takes this ball of leaves, dips it in the water and rubs it in his hands like a cake of soap. The rest of the party, with scoops and baskets, stand a short distance down stream. Almost immediately the fish become *locoed,* rise to the surface, swim wildly in circles, then become insensible, and are easily secured and gathered into the baskets, so powerful is the narcotic principle of the *Charapu.*

CARLOTTA JOAQUINA MAURY

UNIVERSITY REGISTRATION STATISTICS

TO THE EDITOR OF SCIENCE: In the case of Washington University, the comparison of the University Registration statistics published in SCIENCE, January 21, 1916, with those published for the year preceding, shows a loss in the total number of students in that institution. Actually, Washington University had an increase; 174 in the degree conferring departments alone. This apparent loss is due to a change in the classification of a certain

group of students, as reported to me by the university.

These students, numbering 308, were classified November 1, 1914, under "Other Courses," and were included in the total for the university. Unfortunately, for November 1, 1915, the same group of students, numbering 607, were classified under "Extension and Similar Courses"—a classification not included in the total. This makes the discrepancy in the comparison of totals and accounts for the apparent loss reported.

Professor James Sutton, recorder of faculties of the University of California, reports that of the 3,317 students listed in the statistics in SCIENCE of January 21, 1916, under "College," 174 are students in the school of architecture.

JOHN C. BURG

NORTHWESTERN UNIVERSITY

QUOTATIONS

SCIENCE ON THE WAR PATH

No unofficial war document thus far published can compare in importance with the manifesto issued yesterday on the subject of our national neglect of science. The signatories include many of the foremost scientific names of the day. The arguments are crushing in their conclusiveness. Best of all, if it is permissible so to speak, the manifesto is issued at a time when we are face to face with the most lurid of object lessons. The bulk of our failures in the war have been a consequence of our neglect of that scientific energy, strenuousness and organization of which the Germans make so much. We believe their achievements in this field are exaggerated. At the same time, they are far too obvious for us to remain undisturbed by them unless we mean to resign our ancient place in the world.

The signatories of the scientific manifesto point out that our highest ministers of state are mostly ignorant of the obvious facts and principles of "mechanics, chemistry, physics, biology, geography and geology." It will be noted that economics is not included, possibly because it is regarded as a department of biology. The same ignorance, as the scientists say, runs through the public departments of the civil service, and is nearly universal in the House of Commons. Its existence has been demonstrated by the announcement, on the part of a member of the government, that the possibility of making glycerine from lard was a recent discovery. Doubtless some other minister will shortly allude to the law of gravitation or to spectrum analysis as phenomena which have recently come within the cognizance of the government. The remedy for this state of affairs, in the opinion of the distinguished scientists, "is a great change in the education which is administered to the class from which public officials are drawn." Science should play a larger part in the civil servants' examinations, to the exclusion of Latin and Greek. "Eventually, the Board of Trade would be replaced by a Ministry of Science, Commerce and Industry, in full touch with the scientific knowledge of the moment." In those circumstances, the manifesto goes on to say, with an optimism which is almost pathetic, "public opinion would compel the inclusion of great scientific discoverers and inventors as a matter of course in the Privy Council and their occupation in the service of the state." But if the Privy Council is to be filled up with scientific discoverers, how are party hacks and political schemers to be rewarded for their sycophantic services where they can not afford to pay the price for a knighthood or a peerage?

About the peremptory necessity of better scientific organization on national lines there can be no two opinions. It is not only a question of our prosperity, but of our existence. The law of the survival of the fittest works just as inexorably among nations as it does among individuals. We can be the fittest if we like. Unless we *do* like we shall not survive. But if we are to tackle seriously this problem of scientific reorganization, we shall have to scrap the whole of our rotten and antiquated political machinery. The scientific mind and temper can not possibly flourish in an atmosphere of political trickery, nepotism and plunder such as that which has surrounded us for the last few centuries. For

instance, what is the first characteristic of the true scientific spirit? Surely, the desire to ascertain the whole of the facts, and then to pass an unbiased judgment upon them. The true scientist, secure of his data, will follow his intellect whithersoever it leads him. But these principles are reversed under the House of Commons. In what should be the assemblage of the best national intellect there is no place for intellect at all. No private member of the House of Commons is allowed to pass an independent judgment on facts, scientific or otherwise. Before the data are submitted to him he is told what his opinion must be. If he can not quite make up his mind, he taps humbly at the door of the whip's office and is there told what he thinks. The greatest of all scientific achievements is possibly the Newtonian principle that every portion of matter attracts every other portion of matter in the universe with a force proportionate to the respective masses, and inversely as the square of the distance. If, in normal times, the House of Commons were ordered by the whips of the predominant party to pass a resolution that Newton was wrong, and that "every atom of matter in the universe repels every other atom, conversely as the circle of the distance" (whatever that may mean), the members would file into the division lobby with their customary subservience. In normal political circumstances the House of Commons will pass anything, no matter how mischievous or ludicrous if it is ordered so to do. When the national sovereignty is in the hands of such an assemblage of unintellectual automatons as that, he who anticipates legislative sympathy with scientific achievement might with equal prospect of satisfaction hope to taste green cheese from the moon.

Very much the same may be said of the civil servants. All the highest posts are filled by private "influence." They go to the ex-private secretaries of ministers and to the sons, sons-in-law, brothers-in-law, nephews, cousins and other relatives of the men who are already "bosses" in the various departments. Talent and distinction are boycotted. Suppose the greatest of scientific discoverers—a Darwin or a Wallace—to be in rivalry as candidate for a high position in the civil service with some young ass who happened to be the intended son-in-law of a minister or "commissioner." The scientist might as well retire from the contest. The young ass would get the position and a few thousands a year with it. If he were hopelessly unable to discharge the duties, a competent deputy would be engaged at the expense of the taxpayers. That system fills the civil service with the off-scourings of incapacity. Years ago Sir Charles Trevelyan said:

> There is a general tendency to look to the public establishments as a means of securing a maintenance for young men who have no chance of success in the open competition of the legal, medical and mercantile professions . . . the dregs of all other professions are attracted towards the public service as to a secure asylum.

Thanks to this wicked system, it was recently announced that no less than five masterships of the High Court had been bestowed by "influence" on the sons of judges, to the exclusion of hundreds of better-qualified men, who, unfortunately, had not been fathered from the bench. When the administration of justice is itself tainted with nepotism, and when the dregs of every profession are appointed to the highest positions in the public service as a result of private "influence," we have a long way to go before scientific achievement, no matter how distinguished and beneficial, will count for much in this country.

There are, however, some encouraging signs. The political truce is opening the eyes of the public to the stupidity of allowing the British Empire to be run in the interests of political schemers and lazy bureaucrats. Three or four years ago it was a common belief that our insane party system was an essential of effective government. That delusion is gone forever. We are now beginning to understand that an Empire is run on precisely the same lines as a great business. The partners of a great commercial undertaking would not tolerate the presence among them of a man who, like a politician, announced his opposition to proposals before he knew what they were or who,

like a bureaucrat, was incessantly plotting for his own hand and pocket against the interests of the partnership. True science and politics are incompatible. They can not exist together any more than the eagle and the squid can share the same apartment. Science has at this moment the most magnificent opportunity that it has ever enjoyed of seizing the steersmanship of human destiny. Every man who wants to see his country great, progressive and prosperous, marching as a standard-bearer at the head of the advancing legions of mankind, should back the scientists with every ounce of energy that he possesses. If, otherwise, he wishes to see her mean, petty, retrogressive, squalid and contemptible, let him support a return to our debasing party strifes, with their concomitant triumph of the political schemer and all the host of parasites whom he enriches out of public money.—*London Financial News.*

SCIENTIFIC BOOKS

Die Grundlagen der Psychologie. Von Theodor Ziehen. Leipzig und Berlin, B. G. Teubner, 1915. 2 volumes. Pp. vi + 259; vi + 304. Price M. 4.40, geb. M. 5.

Professor Ziehen, long known to psychologists as the author of a very readable "Introduction to Physiological Psychology," has undertaken in his latest work to determine the fundamental principles of psychology. According to his view the science rests upon a twofold basis, its epistemological foundation, and the basal principles of the science itself. The latter may be investigated "autochthonously," that is, with respect to the psychical alone, or in correlation with non-psychical material. The latter investigations furnish the psychophysical and psychophysiological foundations of psychology. In the present work only the epistemological and autochthonous principles are discussed—each in a separate volume.

The author's epistemological standpoint is rigidly phenomenalistic. He starts with the totality of the Given (das Gegebene), which he calls the Gignomene. This primary datum is divided into two fundamental classes, sensations and representations (Vorstellungen). The latter are derivatives of the former. The psychical, which constitutes the subject matter of psychology, is to be regarded as the totality of the Given in relation to a certain "component" of the sensations and representations.

Every sensation datum can be analyzed into two constituents, a "reduction" component and a parallel component. The former is subject to a certain sort of variation—successive changes—and such partial variations constitute the causal series. The second component is subject to a different sort of variation—simultaneous changes—which form the parallel grouping of data. The parallel group includes both independent and dependent variations. The independent variations, so far as we know, occur only in the brain and nervous system. All sensations are subject to dependent variation. Thus among our sense data there are some which stand only in causal and *passive* parallel relations to other data, and some which manifest *active* parallel relations as well —that is, data which produce parallel *effects.* The representative data are resolvable into components analogous to those of sensations. Psychology, according to the author, is the science of the passive parallel components of experience. Such, in bare outline, is Professor Ziehen's demarcation of psychology. Unfortunately, in spite of his endeavor to give mathematical precision to the analysis the meaning of his fundamental terms remains somewhat in doubt.

The fourth chapter contains a very incisive discussion of the historic theories of the Self. The author finds no sufficient ground for assuming the existence of a soul-substance or mind-stuff. The self is merely "an individual collective concept, distinguished by special characteristics" (I., 140). The existence of "other selves" he believes to be comprehensible from his standpoint, while the substance theory, carried out logically, lands us in solipsism.

In Chapter 5 the relation of the "psychical" to the brain is examined. The classic theories, which he designates as causalism, parallelism, materialism, spiritualism, identism and logis-

tical unitarism, are all set down as dualistic. His own solution of the problem is that "the psychical and the material are not two distinct entities, but denote two different kinds of regularity—parallel regularity and causal regularity" (I., 150).

The following chapter treats of consciousness. In common usage the term *consciousness* has three essentially different meanings: it denotes (1) a substantial unitary "self" or "soul," (2) a specific process or function in the psychical sphere, (3) a specific property of the psychical. None of these uses appears satisfactory. According to the author, as already stated, "the psychical denotes not a specific entity, but merely the Gignomene in so far as the latter includes parallel components in accordance with the parallel laws" (I., 206). The notion of unconscious mental processes is not only self contradictory, but it is quite superfluous from his viewpoint. On the other hand, the "reduction constituents" of the datum are unconscious, and in this sense the term "unconscious" has a valid meaning. The first volume concludes with a discussion of the relation of psychology to logic, esthetics and ethics.

In the second part Professor Ziehen develops the autochthonous foundations of psychology. He recognizes both the objective and the subjective methods of research, including under the latter self-observation and observation of others. But according to his view "introspection" is not a special process: it is rather an associative mode of succession of mental processes. The introspection of a sensation is a representation corresponding to that sensation, and the representation of a representation is merely a repetition of the latter. Both induction and deduction are appropriate methods of investigation in psychology proper, whereas in psychophysics and psychophysiology only induction is admissible. Under induction he includes the genetic and experimental methods, but considers the questionnaire method a caricature of the true experimental procedure.

The aim of psychology may be either general or individual. Under general psychology he includes anthropological psychology, animal psychology, and the special fields of general mass psychology and the psychology of types. Under individual psychology he notes one special field: special mass psychology.

The remainder of the work is devoted to an examination of the psychical subject-matter. The two universal characteristics of the psychical are temporality and variability. At the outset the author had divided the primary datum into sensory and representative Gignomene. Whether or not this classification is exhaustive can only be determined by analysis of every sort of experience. Taking up the various types of experience which psychology has recognized as fundamental, he proceeds to show that they are all reducible to sensations and representations, or transformations of representations, or their simultaneous and successive combinations. The author's analysis of judgment, feeling and volition is especially thorough and interesting. Judgment is resolved into a particular sort of representation. The hedonic experiences, instead of forming a third distinct group of data, are found to be merely specific properties of sensations and representations. Volitions are reducible to certain combinations of sensory and representative data—namely, those in which a strong pleasure-tone is united to the representation of a "purpose."

Professor Ziehen's book will interest the psychologist of a speculative turn of mind. His attempt to resolve the data of experience into causal and parallel components is a definite contribution to the mind-body problem. To the present reviewer, though he differs with the author in standpoint, the theory appears to be developed logically from plausible premises. The obscurity of language in the early part of the analysis may be due to the difficulty of defining fundamental ideas such as reduction-component, etc., or it may be the result of attempting to treat non-mathematical terms by means of algebraic symbols and operations. Whatever the reason, the analysis here is exceedingly difficult for even the psychologist to comprehend. It is doubtful whether the physicist and physiologist, to whom these

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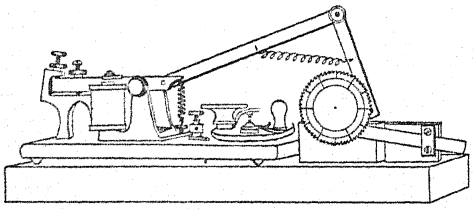
EWING CHRISTIAN COLL. ALLAHABAD, INDIA
WINFIELD DUDGEON

The chief obstacle in employing a free-swinging pendulum for graphic purposes is the difficulty of determining its rate. The methods of coincidence devised by physicists necessitate the use of a standard clock, and are somewhat complicated. The writer has constructed a simple apparatus for recording the exact number of beats in the period tested, which has given very satisfactory results. The figure shows the essential details of its construction.

The common base of a telegraphic sounder and key is fastened to a larger board. A counter for registering rotation is screwed to a small block, with its axis at right angles to the lever of the sounder. A brass disc with 60 ratchet teeth is attached to the end of the axis. The movements of the lever of the sounder are



communicated to the toothed wheel by two strips of steel which are connected by a joint. The first strip is fastened to the right-hand end of the lever with a screw. A pin projects at right angles from the lower end of the second strip. This pin is shaped to fill the interval between two teeth, and acts both as a pawl and an index. The front face of the disc is divided by radial lines which mark the position of every fifth tooth, the tenths being designated by longer lines.

The sounder is placed in the circuit, which is periodically closed and opened by the pendulum that is being tested. When the lever is pulled down by the electromagnets the disc is rotated to the extent of one tooth, and every complete rotation of the wheel is registered by the counter. To prevent the disc from advancing too far when it is suddenly pulled forward, and from recoiling when the pawl moves backward, a clock spring, fastened to a second block, is pressed against the back of the wheel by a screw with a milled head passing through the block. This screw does not appear in the sketch. The degree of pressure required by varying conditions is regulated by experiment. The index is pressed against the wheel by a delicate spiral spring stretched across the angle of the arm. The extent of movement of the arm is regulated by the two screws at the left of the figure. The dropping of the pawl is due to the spring attached to the end of the lever, the tension of the spring being regulated by the screw to which its lower end is fastened. Pieces of paper are placed between the armature and the magnets in order that the lever may return with sufficient rapidity to its original position. When it is desired to use the sounder without the counter, the screw which clamps the arm to the lever is loosened, the arm elevated a little, and the screw again tightened.

The electric counter should be used with a reliable time-piece indicating seconds. The zero mark on the disc is set opposite the index-pawl. When the second hand of the watch is in the desired position, the horizontal lever to which the right hand knob is attached is thrust beneath the spring, which closes the circuit. While the instrument is in operation, the instant when the zero notch is closed by the index is noted from time to time. If at the end of an hour no variation between the indications of the disc and the watch can be detected, the seconds pendulum is considered accurate enough for testing purposes. It should have an error less than one half second in an hour. In using this coincidence method in regulating the rate of the pendulum it is not necessary to read the counter. The counter is only indispensable in finding the number of vibrations when the rate is unknown.

The seconds pendulum which I have employed in my experiments oscillates upon knife-edges of hardened steel, and has a bob weighing 2.4 kilograms. A platinum wire in the lower end of the rod makes contact periodically with a globule of mercury. The length of the tangent of one degree of arc described by the wire in the end of the rod is two centimeters. By holding a millimeter scale horizontally by

the side of the contact it is easy to displace the pendulum one degree, making the arc of vibration two degrees, which is sufficiently great for testing the apparatus an hour.

As the tuning-fork is the standard instrument for measuring and recording short periods of time in physical and physiological experiments, it is very desirable that its exact rate of vibration should be ascertained under the conditions to which it is subjected. It is necessary to employ the graphic method to do this successfully, for the friction and weight of the writing point are liable to affect the rate. A record of considerable length should be taken to minimize the errors due to irregularities in the action of the electric contact. In my own work the smoked paper for the tracing envelops a light aluminium drum which is rapidly rotated by hand. The drum is mounted on a steel axis with a spiral groove cut in it. A pin projecting into the groove causes the drum to rotate in a spiral. As the spiral movement allows long records to be taken, the mean number of vibrations for a considerable period can be ascertained. The motion by hand is very satisfactory, as the rate of rotation can be varied as required. The time-marker in the circuit of the pendulum should write only a few millimeters from the tracing of the fork. In order to do this it is necessary that the axis of the marker should make an angle with that of the fork. I use a clamp for this purpose which holds the object in any position, and permits a delicate adjustment of the writing point. The records that have been obtained with the apparatus have been very regular; variations of small fractions of a vibration were easily detected in them.

Frederick W. Ellis
Monson, Massachusetts

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION M, AGRICULTURE

The second meeting of the Section of Agriculture was held in Townsend Hall, Ohio State University, Columbus, December 28, 1915. The sessions were presided over by the vice-president of the section, Dean E. Davenport, of Illinois. The two features of the meeting were the address of the retiring vice-president, Dr. L. H. Bailey, upon "The Forthcoming Situation in Agricultural Work," already published in Science,[1] and a symposium on "The Relation of Science to Meat Production." The latter was participated in by five speakers who presented various phases of the subject. These papers brought out clearly the complicated and many-sided nature of the problem of meat production and the part which science is playing in promoting, safeguarding and rationalizing the industry.

The symposium was led by President W. O. Thompson, of Ohio State University, who defined "The Nature of the Problem." The background of it lies in the fact that the people of this country have been a meat-eating people for many generations, and any limit to the supply or any excessive cost calls forth widespread protest. The problem of meat production was defined to be largely an economic one in farm management. It has been affected by the numerous changes in agricultural conditions over the country, the extension of farming in the west, the increase in the tenant system, and the development of the dairy industry, even in the vicinity of small towns, all of which have affected the raising and fattening of beef cattle.

The large risk sustained in live-stock keeping has contributed another angle, as has also the problem of advantageous marketing. The problem of maintaining the requisite meat supply is not a haphazard one, but includes very definite phases, such as its relations to systems of farming and to the maintenance of soil fertility, the maintenance of health of live stock to reduce the risk, provision of adequate marketing facilities and conditions, and the intelligent feeding and handling of meat animals. The point was emphasized that the taste for meat has been struggling for existence at the expense of the farmer, and that consideration of the problem of continued supply must be based on broad considerations, in the firm belief that the laborer shall receive his reward.

President H. J. Waters, of the Kansas Agricultural College, enumerated some of the ways in which science may help live-stock farming, as by showing the farmer how a surplus of feed may be carried over, in the silo for example, to equalize the feed supply from year to year; by the proper balancing of feeds, a knowledge of the values of

[1] 1916, Science, N. S., Vol. XLIII., p. 77.

protein from different sources and of the relation of mineral constituents to efficient nutrition, growth and reproduction. Breeding offers further opportunity for improvement, and science may also help the farmer to meet the changes in the demand of the market, as for example, for bacon and ham hogs in place of those furnishing a larger proportion of pork. Already there is a basis for a much better understanding of these matters as a result of recent investigation. Furthermore, a better understanding of factors of growth may assist in cheapening meat production. Investigations upon the stunting effect of deficient food supply has shown the practicability of allowing animals to grow when the farmer has feed for them, and maintaining them on a low basis of nutrition when feed is scarce. The retardation of growth was not found so serious as was formerly thought.

President Waters emphasized the fact that meat production must yield a larger net profit than grain and hay farming to induce farmers to follow it, since it involves more work, more risk, and keeps farmers employed the year round. Any increase in meat production, he prophesized, must come from home production, on the farm mainly and not on the western ranges.

The latter point was borne out by Professor H. W. Mumford, of the University of Illinois, who discussed "The Problem of Meat Production on the High-Priced Lands of the Middle West." He held the corn-surplus states to be the natural center of beef production in this country, since corn-fed cattle are the distinctive feature of the cattle industry and cattle raising in the corn belt provides a farm market for the crop and conserves the fertility of the soil. As a result of changed conditions, however, a large per cent. of the cattle fed in these states are raised in the great breeding grounds of the southwest. Consequently, the business of cattle feeding or finishing has gravitated into the hands of large feeders who deal in carload lots, the capital, risk and business skill involved and the distance from markets having deterred many farmers from going into this line.

In order that beef production in the corn belt may take its proper place it was deemed advisable that the business should be distributed more generally among farms of average size, and that an increasing proportion of the cattle fed in the corn belt be reared there. Further development of the industry was said to depend on a remunerative and reasonably stable market, and no prospect was held out of lower prices. It was prophesied that any considerable increase in the production of beef cattle in the United States will come from the establishment of small herds on many farms rather than of large herds on extensive areas.

"The Economic Aspects of Meat Production and Marketing" were treated by Professor L. D. Hall, of the U. S. Department of Agriculture. The marketing of live stock, particularly of hogs, is coming to be regarded as the limiting factor of their production. The problem of marketing was stated to relate in very large measure to the great central markets, at which more than half of the cattle, two thirds of the swine and approximately four fifths of the sheep of the country are slaughtered. Several conditions and practises which further complicate the problem and favor the buyer were enumerated.

The speaker explained that "every effort should be exerted to take up the slack in a system that contemplates raising a steer in Texas, grazing him in Montana, fattening him in Iowa, selling him in Chicago, slaughtering him at New York, and sending surplus fresh cuts in refrigerator cars as far west as the Missouri River." One feature of the problem was the supplementing of the large central slaughtering establishments with other facilities tending to make markets more accessible to producers, and a tendency in that direction was noted. Furthermore, the provision of more complete official information for growers and feeders as to the supply and distribution of meat animals, both fat stock and feeders, the movement of live stock, quotations at various markets based on standard classes and grades, and the stocks of fresh meat and meat products at principal points, it was maintained would contribute very materially to the stability of conditions and give the producer a truer understanding of the economics of his business.

Dr. A. R. Ward, of the Bureau of Animal Industry, discussed disease control as a factor in meat production, enforcing his remarks by data drawn from the federal inspection of meat and meat animals. He showed the enormity of the direct loss from animal diseases, estimated to amount to approximately $212,000,000 annually, a large proportion of which is from diseases demonstrated to be preventable and controllable. Nearly two per cent. of the animals slaughtered under federal inspection in 1914 were condemned in whole or in part on account of disease. The burden which these losses imposes upon the meat-producing industries of the country was emphasized.

Tuberculosis caused the largest number of condemnations and hog cholera the next. The blighting effect of Texas fever upon a large section of the country was referred to, and the success in the campaign for eradicating the tick causing the disease was pointed out. The results are already apparent in an extension and improvement of the cattle industry.

The importance of the control of animal diseases in relation to the production of meat and the live-stock industry was summed up in the statement: "The good judgment and knowledge possessed by the individual producer of animal-food products concerning the diseases of his animals will determine his success."

The officers elected for the coming year were as follows: Vice-president, Dr. W. H. Jordan, director of the State Agricultural Experiment Station, Geneva, N. Y.; Dean F. B. Mumford, of the University of Missouri, a member of the council, and Dean Alfred Vivian, of Ohio State University, a member of the sectional committee (for five years).

E. W. Allen,
Secretary
U. S. Department of Agriculture

THE AMERICAN SOCIETY OF NATURALISTS

The thirty-third annual meeting of the American Society of Naturalists was held at Ohio State University, Columbus, on December 30, 1915. In affiliation with the society this year were the American Society of Zoologists and the Botanical Society of America.

The report of the treasurer, stating a balance on hand of $676.14, was accepted.

The two following resolutions were adopted.

1. *Resolved,* That the American Society of Naturalists recognizes the urgent need in the United States of reform in the methods of securing evidence of expert opinion in judicial procedure; That the American Society of Naturalists approves the efforts of the American Association for the Advancement of Science in this behalf; and, That the executive committee is hereby authorized and directed to cooperate with the committee of the American Association for the Advancement of Science in the endeavor to bring about such reform.

2. *Resolved,* That the American Society of Naturalists, recognizing the centigrade scale of temperature measurement as based on better principles than that of the Fahrenheit, emphatically urges its adoption by the Senate and House of Representatives as the standard in government publications of the United States of America.

It was ordered that the executive committee of the Naturalists be instructed to appropriate $200 to the Concilium Bibliographicum, Zurich.

A motion that the Naturalists schedule no program at its annual meeting for Thursday forenoon was referred to the executive committee.

There were elected to membership the following: G. A. Baitsell, Yale University; John Belling, Florida Agricultural Experiment Station; G. N. Collins, U. S. Department of Agriculture; W. J. Crozier, Bermuda Biological Station; B. M. Duggar, Missouri Botanical Garden; R. R. Gates, University of California; C. H. Heuser, Wistar Institute; Julian Huxley, Rice Institute; I. J. Kligler, American Museum of Natural History; H. H. Laughlin, Eugenics Record Office; Orren Lloyd-Jones, Iowa State College; L. B. Nice, University of Oklahoma; Oscar Riddle, Carnegie Station for Experimental Evolution; J. W. Scott, University of Wyoming; Gaylord Swindle, Fairview, Mo.; P. F. Swindle, Fairview, Mo.; J. E. Wodsedalek, University of Idaho; S. G. Wright, Bureau of Animal Industries.

By a vote of thanks the society expressed its hearty appreciation of the facilities and courtesies extended by the social committee and by the Ohio State University.

The program of the morning session was as follows:

F. M. Surface, "On the Inheritance of Certain Grain Characters in Oats." (Read by title.)

G. H. Shull, "The Inheritance of Acidia in *Fraxinus americana.*"

I. W. Bailey, "Botanical Evidence in Regard to Climate and Evolution."

A. F. Blakeslee, "Two Plants Adapted to Classwork in Genetics."

E. C. Jeffrey, "Hybridism and the Rate of Evolution in Angiosperms."

L. J. Cole, and W. H. Wright, "The Application of the Pure-line Concept to Bacteria."

Oscar Riddle (by invitation), "Sex Control and Known Correlations in Pigeons."

H. H. Love, "Variations in Daisies." (Read by title.)

C. B. Davenport, "Heredity of Stature."

A. M. Banta, "The Necessity of Sexual Reproduction in Certain *Cladocera.*"

C. C. Little, and E. E. Tyzzer, "Inheritance of

Immunity to a Transplantable Tumor of the Japanese Waltzing Mouse.''

The session of the afternoon consisted of a symposium on the subject ''Recent Advances in the Fundamental Problems of Genetics.''

H. H. Bartlett, ''The Status of the Mutation Theory with Especial Reference to the Genus *Œnothera*.''

W. L. Tower, ''Experimental Reproduction of Recurrent Mutations.''

E. M. East, ''The Significance of Selective Elimination of Gametes and Zygotes in Partially Sterile Hybrids.''

H. S. Jennings, ''Heredity, Variation and Selection in Uniparental Reproduction.''

C. B. Davenport, ''Inheritance of Human Traits.''

The Naturalists' dinner was held on the evening of December 30, at the Hotel Chittenden, with one hundred and fifty in attendance. Professor F. R. Lillie, as president of the Naturalists and vice-president of Section F, American Association for the Advancement of Science, read a paper on ''The History of the Fertilization Problem.''

The officers of the society for 1916 are:

President—Raymond Pearl, Maine Agricultural Experiment Station.

Vice-president—Albert F. Blakeslee, Carnegie Station for Experimental Evolution.

Secretary—Bradley M. Davis, University of Pennsylvania (1914–16).

Treasurer—J. Arthur Harris, Carnegie Station for Experimental Evolution (1915–17).

Additional Members of the Executive Committee—Edward M. East, Harvard University (1916); Henry V. Wilson, University of North Carolina (1915–17); Frank R. Lillie, University of Chicago (1916–18).

BRADLEY M. DAVIS,
Secretary for 1915

THE AMERICAN PSYCHOLOGICAL ASSOCIATION

THE twenty-fourth annual meeting of the American Psychological Association was held at the University of Chicago, December 28, 29 and 30, 1915. The sessions were very largely attended. The program listed more than seventy titles. Of these, twenty-two were studies in mental tests. Animal and educational psychology had eight titles each, while in the field of general experimental psychology there were thirteen papers. Of the remaining number, eight were of a theoretical nature. The address of the president, Professor John B. Watson, of Johns Hopkins University, was on ''The Place of the Conditioned-Reflex in Psychology.'' The speaker explained the method made famous by the Pawlow experiments as it has been adapted for experimentation upon human subjects in the Hopkins Laboratory, and discussed the possibilities of the method as a means of obtaining important psychological results. A special feature of the program was a discussion on ''The Relation of Psychology to Science, Philosophy and Pedagogy in the Academic Curriculum.'' The discussion dealt with the practical relations which psychology must, or should, assume towards the departments of instruction indicated. At the conclusion of the set papers a lively debate turned particularly upon the question of psychology's relation to the training of teachers. Professor C. H. Judd in his paper had contended that psychology is not a necessary prerequisite to the study of pedagogy.

On the day following the close of the meetings some forty members were the guests of Dr. William Healy. The party inspected the Detention Home of the Cook County Juvenile Court, lunched at Hull House, and, during the afternoon, sat with Judge Merritt W. Pinckney at a session of the Juvenile Court. On Monday, January 3, a joint session with Section VIII. (sub-section ''Sociological Medicine'') of the Pan-American Scientific Congress was held at the Raleigh Hotel, Washington, D. C.

As officers for the current year, Professor Raymond Dodge, of Wesleyan University, was elected president, while Professors H. A. Carr, of the University of Chicago, and Knight Dunlap, of the Johns Hopkins University, were selected to succeed Professors J. W. Baird and Madison Bentley on the council. An invitation extended by the department of psychology to hold the next annual meeting at Columbia University was accepted. The meeting will occur during ''Convocation Week'' in affiliation with the American Association for the Advancement of Science. A resolution introduced by a number of past-presidents of the association was voted, which provides for some special observance of this, the twenty-fifth annual meeting of the association.

The tentative plan of conducting election to office in the association which has been in operation for the past three years, will be continued with certain modifications. Hereafter the committee having this matter in charge will function

as an election committee, and will communicate with all members of the association, first, to secure a primary ballot of nominations, and again to secure a ballot of election; votes being taken from a list of candidates receiving the highest number of ballots in the primary. In its modified form this method of election is now before the association as a constitutional amendment.

A resolution was passed to the effect that the association "discourage the use of mental tests for practical psychological diagnosis by individuals psychologically unqualified for this work." By resolution, also, the retiring president was authorized to appoint a committee for the purpose of expressing approval of plans for the establishment of a station for the study of the behavior of primates. The committee, as appointed, consists of Professor J. R. Angell, University of Chicago, chairman; Professor Raymond Dodge, Wesleyan University; President G. Stanley Hall, Clark University; Professor G. M. Stratton, University of California, and Professor E. L. Thorndike, Teachers College, Columbia University.

R. M. Ogden,
Secretary

THE BOTANICAL SOCIETY OF AMERICA. III

Fiber Measurement Studies: A Comparison of Tracheid Dimensions in Longleaf Pine and Douglas Fir, with Data on the Strength and Length, Mean Diameter and Thickness of Wall of the Tracheids: Eloise Gerry.

This paper is a progress report on the fiber dimension studies that are being made as a part of the investigation into the mechanical, physical and chemical properties of Longleaf pine, *Pinus palustris* and Douglas fir, *Pseudotsuga taxifolia* at the U. S. Department of Agriculture, Forest Products Laboratory, which is maintained in cooperation with the University of Wisconsin at Madison, Wisconsin. The microscopic investigations were made at every tenth annual ring on large cross section from old trees. The following data were recorded for each ring: Age, width, per cent. of summer-wood, height above the ground, distance from the pith, and resin content. Fifty measurements were made of the length, mean diameter and thickness of wall to obtain average. The spring and summer-wood were recorded separately. A number of tracheids proportional, respectively, to the per cents. of spring and summer-wood in the ring were measured. This data supplements that previously presented. It includes a summary of over 7,000 measurements on Douglas fir and 5,000 on longleaf pine. The results are as follows: (1) No evidence could be found for a constant fiber length such as was reported by Sanio for the Scots pine. (2) There are many more bordered pits in the spring than in the summer-wood tracheids. The ends of the tracheids may frequently be blunt or forked. They are generally very pointed in the summer-wood. (3) The summer-wood tracheids in any ring are, in general, shorter than the spring-wood tracheids in all the material studied. (4) There is a rapid increase in all dimensions during the first twenty years. (5) The variation in length in a single tree was found in one disk to be .80–7.65 mm. (6) A direct relation appears to exist in the Douglas fir studied between the thickness of the cell walls of the summer-wood and the strength of the material. The thickness of wall and strength of material were both low in young material. (7) No marked relation was found between width of ring and fiber dimensions. A tendency was noted for the young wide-ringed material to have relatively short, narrow tracheids with thin walls. (8) In studying a 455-year-old Douglas fir the possibility was considered of finding indications of old age or decline indicated in the size of the elements. No such effect was discovered. (9) The Douglas fir and pine did not vary widely in the dimensions of their elements. The thickness of wall averaged high in the longleaf pine, but the diameters were somewhat less than those in fir.

Xerofotic Movements in Leaves: Frank C. Gates.

Xerofotic movements are paratonic movements, caused by unequal drying effects in direct sunlight, manifested by an upward bend in the leaflets, or the curling upward of the blade. The upward movement is produced by differential turgidity in certain cells. The greater turgidity of the cells on the lower, less exposed side causes the organ to move upwards. In the *localized* xerofotic response, the differential turgidity is largely confined to a small region, for example, the pulvini of leguminous leaflets. In the *generalized* response, the blade of the leaf curls or rolls upwards. The monocot families, Poaceae, Araceae, Marantaceae and Zingiberaceae furnish examples of the generalized response. The Leguminosae furnish the best examples of the localized response, with which this paper deals. Whether the night position of the leaflets is erect or drooping, the xerofotic response is between 45° and 70° above the horizontal or normal day position.

Variations of exposure result in variations of response, even in leaflets of a pair. The xerofotic position decreases the amount of direct radiant energy received per unit area of leaf, reducing the harmful action of too intense sunlight on the chlorophyll, as well as checking the transpiration. Experimental work with screens upon *Gliricidia sepium*, *Leucaena glauca*, *Mimosa pudica* and *Ipomoea pes-caprae* limited the causation of the xerofotic response to the action of direct sunlight. The application of chemical drying agents (absolute alcohol and xylol) to the upper side of the large pulvini of *Gliricidia sepium* and to the upper side of the midrib of the clam-shaped leaves of the strand plant, *Ipomoea pes-caprae*, resulted in the assumption of the xerofotic position.

The Osmotic Value of Sea Water and the Osmotic Surplus of Several Marine Algae: R. H. TRUE.

The osmotic value of sea water was determined by the plasmolytic method, *Spirogyra* calibrated by means of NaCl and cane sugar solutions being used as an osmometer. The value so obtained was compared with the values obtained by the freezing-point method and found to agree fairly closely. The osmotic value of several marine algae was also determined and the osmotic surplus was shown to be of the same order of magnitude as that seen in higher land plants.

Measurement of the Surface Forces in Soils: CHARLES A. SHULL.

The internal forces causing absorption of water by dry *Xanthium* seeds have been measured and found to have an initial value of at least nine hundred and sixty-five atmospheres. The internal forces have been determined at various contents covering the range between air-dry and saturation. Dry seeds have been used to measure the surface-holding power of soils for water, with the result that air-dry soils hold water with approximately the same force as an air-dry seed (900–1,000 atms.). As the capillary moisture increases the surface force decreases, until, at the wilting coefficient of the soil, the amount of "back pull" exerted is not more than three or four atmospheres. This relation holds essentially for all types of soil from heavy clay to sand. The soil, therefore, at the critical moisture content for the plant, holds the water with less force than the osmotic pressure of the root hairs of plants, as determined by plasmolytic methods. The wilting of the plant at the wilting coefficient does not result from lack of moisture, or lack of a gradient toward the plant, but probably from the low rate of movement of water as the friction of movement in thin films increases.

The Interrelation of Transpiration, Root Absorption and Water-absorbing Capacity of Tissues in an Opuntia: EDITH B. SHREVE.

Previous workers have found that the transpiring power (*i. e.*, the absolute transpiration rate divided by the evaporative power of the air for the same period) is greater in cacti for the night than for the day. The following is a general summary of the results of an investigation into the causes of this phenomenon. (1) The transpiring power is greatly influenced by light intensity, air temperature, water-content of tissues and available soil water; and these factors very clearly exert their influence indirectly through their action on some other internal process. (2) The day-to-night variations in transpiring power are independent of any day-to-night variations in root absorption. (3) During the daylight hours more water is absorbed by the roots than is lost by transpiration, while at night the reverse is true. (4) Variations in water-intake by the roots are due, on the one hand, to variations in soil retentivity and, on the other, to variations of conditions within the plant itself, and the latter may be subdivided into variations in the absolute transpiration rate and in the water-absorbing power of the tissues. The variations in soil retentivity may be reduced to zero by the use of water cultures and of supersaturated soils. Then on dividing the absolute rate of water-intake at the roots by the absolute transpiration rate for the same period, a quantity is obtained which must represent that part of the root absorption which is independent of variations in transpiration as well as in the retentivity of the soil. This quantity (A/T) has been termed the secondary absorbing power of the roots. Its variations are independent of transpiration, and furthermore, it varies inversely with transpiring power. That is, A/T is greater for the day than for the night and T/E is greater for the night than for the day. (6) Stomata are, in general, shut during the day and open at night, but it is not possible to ascertain whether the closing of the stomata accompanies or follows a decrease in transpiration rate. (7) The water-absorbing capacity of cylinders cut from the internal tissue is less at night than during the day, being least from 4 to 5 A.M. and greatest from 3 to 5 P.M. This is true whether the calculations are based on dry weight or on original wet weight. (8) The theory is advanced that the water-absorbing ca-

pacity of the internal tissue controls the secondary absorbing power of the roots and probably also the transpiring power, since a greater absorbing capacity would mean also a greater resistance capacity to the loss of water. It seems quite possible that in the forenoon the increasing absorbing capacity of the internal tissues may take water from the guard cells, thus causing them to close, and at night the decreasing water-holding capacity may allow the guard cells to take water from the internal tissues, and thus open. The effects exerted by light intensity and air temperature, together with their duration, show that the variations in absorbing capacity are due, at least in part, to chemical changes brought about by the metabolic processes. Many tests showed that the changes in the water-absorbing capacity of the tissues parallel acidity changes in the plants in such a way that when the acidity is highest the absorbing capacity is lowest, and *vice versa*. However, certain exceptions which occur under controlled conditions show that the relation can not be so simple as the influence of mere changes of H-ion concentration. Consequently other factors must be taken into consideration, including the accumulation and disappearance of the salts of organic acids. It is impossible to state yet whether the absorbing capacity of the internal tissue is due to colloidal absorption or to osmotic forces or to both. Although the concentration changes in the total sap which are indicated by the known changes caused by the metabolic changes and by the changes in water-content seem to show that osmotic forces are not of prime importance in controlling the water-absorbing capacity of tissues, still there is no direct proof that it is colloidal absorption which is the sole or the controlling force.

Physiological Temperature Indices for the Study of Plant Growth in Relation to Climate: Burton E. Livingston.

The aim of this study is to obtain indices of temperature efficiency for plant growth, by means of which temperatures on the thermometer scale may be weighted in evaluating the temperature term of the environmental complex in physiological, agricultural, forestal and ecological investigation. The system of indices here brought forward is based on the results of Lehenbauer's recent study of the relation of temperature to growth of young maize shoots exposed twelve hours to maintained temperature. Lehenbauer's graph is first smoothed mechanically, and then the ordinates for each degree of temperature are measured. These are all expressed in terms of the ordinate for 40° F. (4.5° C.) taken as unity. The index values increase from zero (2° C.) through unity (4.5° C.) to 122 (32° C.), and then decrease again to zero (48° C.). This is the first system of temperature efficiency indices that takes account of the optimum and maximum in the growth-temperature graph. A chart of the climatic zonation of the United States with respect to temperature efficiency for plant growth during the period of the average frostless season is shown, based on the new indices.

A Single Climatic Index to Represent Both Moisture and Temperature Conditions as Related to Plants: Burton E. Livingston.

A method is described by which the indices of precipitation, of atmospheric evaporating power, and of temperature efficiency for plant growth, for any period of time, may be combined into a single index of moisture-temperature efficiency. The new index is the product of the rainfall-evaporation ratio and the summation index of temperature efficiency for the period. The method is only a first approximation and improvements are of course to be expected. By means of these moisture-temperature indices a new climatic chart of the United States is constructed, for the period of the average frostless season. This chart shows that, as far as moisture and temperature conditions are concerned, peninsular Florida possesses the best climate for plant growth, while the least efficient climates of the country are those of the extreme north and of the arid regions. The natural climate of the arid regions is modified by irrigation, and that of the cold regions is modified, on a small scale, by artificially heated greenhouses.

A Living Climatological Instrument: B. E. Livingston and F. T. McLean.

While methods for interpreting instrumental records of climatological conditions are being devised, climates may be studied and compared in terms of their actual effectiveness in promoting growth of standard plants. In the first trial of this method the plants were grown in plunged pots, always filled with the same kind of soil, which was renewed after each culture. Ten different stations in Maryland were employed. Soy bean proved very satisfactory as a standard plant. Seeds were soaked in water at a given temperature for a certain time before planting. Various measurements were made on the plants after two weeks and

again after four weeks, when cultures were discontinued. New cultures were started every two weeks. The plant here is regarded as a self-integrating instrument set at zero of its scale at beginning of each four-week exposure period, and the integrations of climatic efficiency for plant growth are read in terms of plant measurements after two and after four weeks, when the instruments are again set at zero. The value of the climate for any two-week or four-week period at any station may be compared with that for any other period, either at the same or at another station.

The Daily March of Transpiring Power as Indicated by the Porometer and by Standardized Hygrometric Paper: SAM F. TRELEASE AND BURTON E. LIVINGSTON.

The transpiring power was determined for the lower surfaces of *Zebrina* leaves at intervals throughout day and night, by method of standardized cobalt chloride paper. At the same intervals porometer readings were made. If porometer rates are proportional to average cross-sectional area of stomatal pores, then stomatal diffusive capacity (Brown and Escombe) should be proportional to square root of porometer rate at any time. Graphs of this diffusive capacity and of transpiring power were made for the same periods. Both graphs agree in showing the same kind of daily march; values of both indices rise to maximum in day and fall to minimum in night. But the range of variation between minimum and maximum values is generally somewhat greater for indices of diffusive capacity. It appears that porometer rates do furnish data for deriving stomatal diffusive capacity in this case, but that this capacity is not quite proportional to transpiring power; transpiring power is here mainly dependent upon degree of stomatal opening, but other conditions are influential. If the index of transpiring power for each determination be divided by the corresponding square root of the porometer rate, a value is obtained that appears to be approximately proportional to the non-stomatal influence upon transpiring power.

The Transpiring Power of Plants as Influenced by Differences of Altitude and Habitat: FORREST SHREVE.

Measurements of the transpiring power of the leaves of some twenty species of plants were made in the Desert and Encinal regions of the Santa Catalina Mountains in southern Arizona in the arid foresummer of 1915. The method of standardized hygrometric paper was used on the plants in their natural habitats. The species investigated belonged to various life-forms. They differed both in the values of their transpiring power and in the character of its daily changes. The same species exhibits a higher transpiring power in the individuals which grow in flood plains than in those which grow on arid slopes. The daily changes in the former individuals are concordant with the daily march of evaporation; while in the latter case the transpiring power falls sharply before the daily maximum of evaporation is reached. A comparison of the transpiring power of the same species at different elevations has shown that the daily check is applied earlier in the day at lower elevations and later at higher ones. The check is manifested, for example, in Emory oak at 5,000 feet, but is in abeyance at 6,000 feet, where the maximum transpiring power and maximum evaporation are simultaneous. In the mesquite the check is applied earlier on the desert at 2,500 feet, later at 4,200 feet and at 5,000 feet, but is not eliminated at the upper limit of the species at the last-named elevation. The values for the transpiring power are in all cases higher at lower elevations, but at the higher elevations the values, although not so high, are sustained through a longer portion of the day.

Cultures of Uredineae in 1915: J. C. ARTHUR.

The report upon rust cultures for the season of 1915 makes the fourteenth covering consecutive work, which was begun in 1899. An interesting observation on the production of the alternate stage of rye rust upon *Anchusa* is given. Aecia of *Puccinia Seymouriana* on *Spartina,* heretofore only known upon *Cephalanthus,* were grown upon hosts representing two additional families. Another species of *Puccinia* on *Spartina* of limited distribution in the northwest is shown to be the correlated form of *Uromyces Spartinae,* and from the southwest a species of *Uromyces* on wild *Hordeum* is conversely found to be the correlated form of the common barley rust, *Puccinia Hordei,* thus adding further proof of the essential identity of the genera *Uromyces* and *Puccinia. Puccinia Eriophori* Thüm., in both its aecial and its telial forms, is established as a widespread American species. Altogether about twenty successful cultures were obtained, supplying various items of information, partly confirmatory and partly new.

The Injurious Effect of Tarvia Fumes on Vegetation: A. H. CHIVERS.

An account is given of the destruction of a gar-

den at Hanover, New Hampshire, by fumes of a tar compound known as tarvia which was melted at a time when atmospheric conditions were such as to cause the fumes to hug the ground and blow over the near-by garden, with the result that at least twenty species were killed or severely injured. The rapid and characteristic action of the fumes seemed to favor certain conclusions. A brief review of literature regarding smoke and fumes is given, together with a brief description of a series of experiments which indicate that the following is true regarding the nature of the injury. (1) The injury was due to the constituents of the volatile substances which condensed in the form of an oily coating on the surfaces of the plants. (2) The injury did not involve, to any extent at least, the passage of gases through stomata. (3) The injury was due to the action of the fumes on aerial parts. (4) The injury varied with the distance from the escaping fumes, the temperature of the melting tar, and the age of the plant structures.

A Canker of Apple Caused by Plenodomus fuscomaculans: G. H. Coons.

A serious canker of apple has been found in some orchards in northern Michigan. This canker is characterized by the elongated lesions which are commonly accompanied by checking of the bark into small squares or rectangles. Lesions are found extending along the limb, commonly on the under side. These are the result of the killing of the bark in strips. In the older cankers the killed bark drops off, leaving the bare wood. One limb may show all stages of the trouble, from freshly killed bark to the decorticated wood. In the bark and especially on the bare wood pycnidia are found in abundance. The wooly aphid by its attack makes the canker very unsightly and greatly interferes with the natural healing of the wound. The causal relation of an associated organism, *Aposphaeria fuscomaculans* Sacc. has been shown by the ordinary rules of proof. Recent work on the genera of the Sphaeropsidales has given cause for rearrangement in the old genera. From a study of the morphology of the organism associated with this canker, it has seemed advisable to transfer the fungus to the genus *Plenodomus*. The physiological relations of the causal organism has been studied at considerable length, but an account of these is being published separately in the *Journal of Agricultural Research*. The results may be summarized by stating that this organism shows relations to environmental factors, quite as sharp as those reported by Klebs for *Saprolegnia* and other fungi. In particular light was found essential for pycnidium formations. Successful inoculations were obtained on the limbs of Wealthy, Duchess, Jonathan and Ben Davis apple as well as upon the Hyslop crab. Other standard varieties seem more resistant, especially the Northern Spy. The fungus has been successfully inoculated into pear, small cankers being formed. No successful inoculations could be obtained on apple leaves. Apple fruits of various kinds are only very slightly invaded by the fungus, no conspicuous rotting or spotting being caused. The fungus shows marked attenuation after being grown in culture. The disease has been successfully controlled by methods commonly advised for apple canker.

Recent Contributions to our Knowledge of the Genus Gymnosporangium: Frank D. Kern.

A little more than four years ago the writer published an account of the genus *Gymnosporangium*, "A Biologic and Taxonomic Study of the genus *Gymnosporangium*," which purported, as the title indicated, to cover all of the information available at that time relative to the biology and taxonomy of these plants. Since that time there have appeared more than a dozen papers which have contributed additional facts to our knowledge of this interesting genus. These contributions have been of varied interest, some concerning life-histories, others relating to anatomy, physiology, taxonomy, distribution or pathologic importance. The scattered condition of the additional information, as well as the accumulation in the writer's hands of unpublished data, has suggested the idea of bringing together in one account the more important facts. The appended bibliography, in connection with the one formerly given, will serve to direct any one to the original sources provided exceptions may be taken to any interpretations here given. With the exception of a broad general statement it seems most satisfactory to make an arrangement of notes under specific headings since, for the most part, references deal with individual species rather than the genus as a whole. Among the more notable points brought out in the various special papers may be mentioned the report of another aecial host outside the Rosales, the finding of teliospores in the species possessing uredinia, studies upon the effects produced by the hosts upon the morphology of the fungi, and active investigations of the species causing diseases of economic importance.

The Relation of the Seed Stock to the Control of Bean Anthracnose and Bean Blight: J. H. MUNCIE.

On account of the enormous losses caused by them, the diseases, anthracnose and blight, have become a serious menace to the bean-growing industry of the United States. For the season of 1915 it is estimated that the loss, to the Michigan bean crop alone, is at least a million bushels and the money loss about two and one half million dollars. The control measures, recommended by various authors, incorporated with our own, have been tried out in our experimental plats. These measures consist of the application of fungicides to the growing plants and treatment of the seed with chemical solutions and hot water. In no case did these measures prove satisfactory in controlling the diseases. Likewise the planting of native seed from some of the western states proved unsatisfactory. It has been found possible to grow Michigan seed beans in western states where the climate is favorable and where these diseases are of no economic importance, and to secure, in this way, seed apparently free from disease. The behavior of the plants from western-grown Michigan seed will be further tested in our experimental plats. Since spraying and seed treatments have failed to control these diseases, we have sought for a palliative, to be employed until some satisfactory control measure can be worked out. We have found that by planting a variety of beans of high productivity, the losses due to these diseases can be so decreased that, in ordinary years, they will not be burdensome to the industry. This variety of pea beans is known commercially in Michigan as the Early Wonder. According to Mr. W. W. Tracy, of the U. S. Department of Agriculture, this variety was heard of in western New York, in 1890, as the Little Early Scofield. Seed from a single plant was first grown in Michigan in about 1908. Later, when seed from this variety was put on the market the varietal name was changed to Early Wonder. Early Wonder beans have been observed under field conditions in six of the principal bean-growing counties of this state, during the past three seasons. At least two thousand acres of beans of this variety were under observation this season. This variety of beans is well adapted to Michigan conditions, matures early and produces well. On account of this early ripening, the pods harden before the diseases have made serious inroads into the tissue, thus preventing to a great extent the spotting of the seed. Data collected for the past three seasons bring out the following points: (1) Early Wonder beans ripen from ten days to two weeks earlier than ordinary home-grown varieties. (2) The average yield per acre is twenty bushels. (3) The average pick per bushel is two pounds. (4) The seed is uniform in size, shape and color. (5) The pods ripen evenly and hang high above the ground. (6) Early Wonder beans produce well, even under severe disease and weather conditions. We are recommending that true Early Wonder beans be planted in Michigan as a palliative measure until some more successful control measure for the anthracnose and blight can be found.

New Methods and Apparatus for Determining, Qualitatively and Quantitatively, the Effects of Sulphur Dioxide on Plants: P. J. O'GARA.

A résumé of the work done by European and American workers is given. It is shown that the methods of sulphur dioxide analyses have been in error, this error often reaching up to one thousand per cent. or more. Furthermore, the type of apparatus used in subjecting plants to an atmosphere containing sulphur dioxide gas was faulty. In addition it may be stated that the effects of the various environmental factors, such as temperature, humidity and light, were not sufficiently taken into consideration as affecting plants subjected to an atmosphere containing sulphur dioxide. The methods employed in the experimental work which has been carried on by the writer and his assistants have been such as to take into account every factor which would influence the effects of sulphur dioxide on plants. For the first time it has been possible to measure accurately extremely minute quantities of sulphur dioxide. It has been possible to subject plants to known concentrations of sulphur dioxide and to check these concentrations during the progress of the experiments. During the seasons of 1914 and 1915 twenty-six agricultural crops were investigated, the purpose being to determine qualitatively and quantitatively the effects of sulphur dioxide when employed at various concentrations and at the various periods of growth of the various crops. During the two years during which the experimental work has been carried on fully two thousand experimental plots have been used. The new methods and appliances will be shown by the use of a large number of lantern slides.

Concerning Certain Peculiar Tissue-strands in a Protomyces Gall on Ambrosia Trifida: ALBAN STEWART.

The stems of the great rag-weed, *Ambrosia trifida,* are sometimes infected by *Protomyces*

andinus Lagh. causing the formation of large galls. These usually occur just above the ground, but it is often the case that they may also occur higher up on the stem, as much as two feet above the galls, which are located near the roots. Both kinds of galls have essentially the same histological structure. In the deeper portions of the galls, near the pith where infection evidently starts, peculiar tissue-strands are formed which are similar in some respects to the tumor strands which have been found in the stems of certain plants infected with the crown-gall organism, *Pseudomonas tumefaciens*. The strands consist of whorl-like arrangements of thin-walled cambiform cells which usually enclose groups of sporanges of the fungus. Short tracheids sometimes accompany the strands. The strands may occur singly or in groups, and usually run in a vertical direction. They have been found both in the galls located near the ground and in those higher up on the stem, but there is no indication of them in the normal part of the stem between two such galls. They are purely local and have no relation one gall with another. The fact that abnormalities in the tissues of the host plant are to be found in or nearly to the pith in the infected parts, indicates that the stems become infected while they are still quite young, probably before secondary thickening starts. This offers a possible explanation as to how the upper galls on the stems come about. In the young seedling plant there are a number of short internodes formed near the ground which lengthen out by subsequent growth. If the lower internodes should become infected at this time the infected parts would probably be carried up later by the lengthening of the stem.

Anthracnose (Colletotrichum lagenarium (Pass.) E. and H.) a Serious Disease of Cucurbits (preliminary report): J. J. Taubenhaus.

Watermelons, cantaloups and cucumbers are important crops in the trucking districts of Delaware. Of late growers are experiencing great difficulty in raising these cucurbits, especially watermelons. Conditions are similar in neighboring states of New Jersey, Maryland and Virginia. Investigations on cucurbit diseases undertaken at Delaware have shown that the difficulties mentioned are occasioned by several diseases. One of the chief causes of failure of watermelons in Delaware and vicinity is the anthracnose disease. The latter causes a deep spotting on the rind of the fruit impairing its shipping quality. The disease, too, is the cause of a serious leaf spot, and a blight and canker of the vines. The attacks are severest on the watermelon crop in its second successive year. For this reason growers are forced to practise a rotation of six years or longer. *Colletotrichum lagenarium* also causes a serious leaf and fruit disease of cucumbers and citrons, the latter of which are usually considered the most immune of all cucurbit plants. It also attacks the fruits of cantaloups and the ornamental gourd. Pumpkins and squashes seem to be free from the attacks of the fungus. Cultures of *Colletotrichum lagenarium* from all the cucurbitaceous hosts mentioned are very easy to obtain. Cross inoculations with pure cultures have shown that the anthracnose from watermelons, cantaloups, cucumbers, citrons and ornamental gourd are all one and the same; the disease may be readily transferred from one to the other. Investigations are now under way to determine the life history of *Colletotrichum lagenarium*, its relationship to the various hosts and to other species of Colletotrichums, especially *C. lindemuthianum*, and methods of control. Besides anthracnose there are two other apparently new diseases of the watermelon which are being investigated.

Fungi producing the Heart-rot of the Apple: B. O. Dodge.

Polyporus admirabilis Peck was found on many living apple trees at Litchfield, Conn., during the month of August. The fruit bodies were growing singly or in clusters. Individual sporophores vary in size from ten to forty centimeters in diameter. The heart-wood is first attacked and the fungus gradually encroaches on the sap-wood until the limbs and trunk are weakened to such an extent that they are broken down during wind-storms. Apple trees of the east are more commonly attacked by another type of polypore. These are the white bracket forms frequently found on the inside of hollow trees near knotholes. When growing on the outside of a tree the mycelium penetrates the sap-wood up and down for some distance so that the base of the trunk may bear a large number of imbricated sporophores. This type of fungus belongs to the *Spongipellis* group. *Polyporus galactinus*, or *Polyporus spumeus* var. *malicola* is the species found in the old apple orchards of the New England states. The form attacking the apple tree in Virginia, identified as *Polyporus fissilis*, is very near to *P. galactinus*, but it has larger pores and thicker flesh.

H. H. Bartlett,
Secretary

SCIENCE

FRIDAY, MARCH 17, 1916

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AIMS, METHODS, AND RESULTS IN MEDICAL EDUCATION[1]

MEDICAL education represents an organized attempt to train men to apply scientific methods to the prevention, cure or alleviation of disease and to the advance of medical knowledge. To this end the public, the teachers and the students all contribute. The public through endowment or state support now pays the more liberally supported schools at least $300 per year per student, or $1,200 for the four-year course; the teachers by rendering skilled service for less than what they might earn in practise probably contribute at least as much, while the time of the student in addition to his tuition fees and other expenses makes his contribution worth not less than $1,000 per year or $4,000 for the course, in addition to which he usually devotes several thousand dollars' worth of time to postgraduate study.

The public gets the largest returns from the investment both from the advances in medical knowledge which come from the better supported schools and from the increased efficiency of medical service which benefits not only those individuals who pay for services received but also the community at large. The students, who furnish by far the largest part of the investment, may ultimately get some fair financial return from this investment but must look to joy of service for the chief return. The teachers find their main reward in the companionship with youth in devotion to ideals.

[1] Presidential address at the annual meeting of the Association of American Medical Colleges, Chicago, February 8, 1916.

The results of the joint product of educational plants, teachers and students, are to be determined, on the one hand by the scientific output of the institution and on the other hand by the ability of the graduates to perform the services for which they are trained. This ability does not become fully manifest until the youths of to-day become the mature men of to-morrow. We do not manufacture a product ready to work perfectly the minute it is turned out and for which there is an eager market to stimulate us to devise methods of turning out an ever greater quantity at less cost. On the contrary we have to devise methods which will train men to fill in a worthy way the medical needs of the nation a generation in the future, men for whom when first turned out the public does not seem particularly eager.

Our methods should be designed to furnish the requisite training as directly, simply and inexpensively as possible, compatible with adequate results. In studying and trying out methods we should, however, focus our attention on the end results desired, not on artificial standards such as have at times been introduced by efficiency engineers and other professional students of other peoples' business who have been active of late in the field of education and who are apt, because of the difficulty of determining the nature of the products of an educational institution, to adopt some such standard as the unit hour of instruction as the product or to base estimates of efficiency on the elaboration of machinery. On the whole, however, I believe that we have been fortunate in the breadth of view shown by outside investigators of our own field of education and that we ourselves are to be blamed for too much emphasis on time requirements, too great a readiness to standardize without sufficient study of the ultimate result produced. This attitude has led to a condition where the requirement of two years of premedical college work has made much more rapid progress in the requirements of licensure to practise in various states than have practical examinations in medicine.

Under the cheaper methods of medical instruction which prevailed in this country until recent years the results on the whole were not satisfactory. It has been stated that as many as forty per cent. of medical graduates quit the practise of medicine within a few years after leaving the medical school. Of the rest some by natural ability and hard study subsequent to graduation became of great value to society and others, allowing themselves to drift, became venders of prescriptions but not men able to apply modern science to relieve disease.

The recent developments in medical education have added greatly to the expense of maintaining medical schools and to the cost in time and money to those seeking a medical education. Are the results satisfactory? Can they be improved? Can the expense be reduced without injuring the product? These questions can not be answered satisfactorily at the present time, first, because of the relatively short period that the newer methods of medical education have been in force and, second, because of the absence of satisfactory records of the subsequent careers of our graduates. They are, however, questions which every institution should carefully study and from time to time various institutions should report the results of such studies because of the help to other institutions thus furnished. Only one institution, at present, the Johns Hopkins Medical School, I believe, furnishes an account of the subsequent careers of each of its graduates. Since this institution was the first

to assume what have since become, with a few modifications, the modern standards of medical education in this country[2] a statistical study of the careers of the graduates of the first ten years, 1897–1906 inclusive, may be of value in throwing light on the results produced by recent trends in medical education. To me the study has been of special interest because I was a member of the first class and assisted in teaching the other classes.

TABLE I

Careers of Graduates

(J. H. U., 1897–1906)

	Total Number	Women	First 5 Classes	Second 5 Classes
	456	55	166	290
Died	5.7%	7.3%	8.4%	4.1%
Withdrawn	3.3	18.2	6	1.8
Practise	80	70.9	71.1	85.2
Science	8.8	1.8	13.3	6.2
Administration	2.2	1.8	1.2	2.8

[2] The requirement of premedical college work covering physics, chemistry, biology and a modern language, adopted to the extent of one year by the Association of American Medical Colleges and to the extent of two or more years by a large proportion of the schools in the association is a modification of the requirements adopted by the Johns Hopkins Medical School beginning with the first class which entered in 1893. For matriculation a student was required to have a college degree and to have had college training in physics, chemistry and biology, a reading knowledge of French and German and as much Latin as may be studied in two years in a high school. With the exception of the last, the only high-school subject specifically required, and some of the modern language which could be studied in the high school, the specific requirements of the Johns Hopkins could be covered by two years of college work. The standards now adopted by most of the better schools are quite similar except that but one modern language is required instead of two. Furthermore, the Johns Hopkins curriculum devoted the first two years to work in the basal medical sciences, the last two to clinical work, an arrangement in the main now generally adopted. The standard of full-time teachers and investigators in the basal sciences then established has likewise been widely accepted.

TABLE II

Fields of Practise

(J. H. U. Graduates, 1897–1906)

	Total in Practise	Women in Practise	First 5 Classes	Second 5 Classes
	365	39	118	247
General practise without specialization	22.2%	35.8%	16.9%	24.7%
General practise with specialization	20.5	46.1	18.7	21.5
Internists	9.6		18.7	5.3
Medical specialties	11.2	7.7	5.1	14.2
General surgery	15.9		17.8	15
Surgical specialties	9.9		10.2	9.7
Eye, ear, nose and throat	5.2		6.8	4.1
Obstetrics	5.5	10.2	5.9	5.3

TABLE III

Subdivisions of Activities

(J. H. U. Graduates, 1897–1906)

General Practise

Number of Individuals, 156

	Per Cent.
No specialty indicated	51.9
General practise combined with	
Public health work	9
Laboratory work	7.8
Pediatrics	5.8
Obstetrics	1.9
Surgery	10.9
U. S. army surgeons	3.8
Institutional work	3.8
Medical missionaries	5.1

Teachers, 7.7 per cent.

Medicine

Number of Individuals, 76

	Per Cent.
Internists	46
Pediatrists	14.5
Neurologists	10.5
Dermatologists	8
Laboratory diagnosis	21.0

Teachers, 63.2 per cent.

Surgery

Number of Individuals, 133

	Per Cent.
General surgery	43.6
Gynecology	10.5
Orthopedics	7.5
Genito-urinary surgery	9
Eye, ear, nose and throat	14.3
Obstetrics	15

Teachers, 42.1 per cent.

Science

Number of Individuals, 40

	Per Cent.
Anatomy	15
Bacteriology	2.5
Physiology	15
Hygiene	5
Roentgenology	2.5
Pharmacology	7.5
Medicine	12.5
Pathology	40

Teachers, 90 per cent.

Administration

Number of Individuals, 10

	Per Cent.
Hospital	50
Public health	40
Medical association	10

Teachers, 0

Four hundred and fifty-six students were graduated in the ten classes under consideration, 166 in the first five classes, 290 in the second five classes. Fifty-five were women.

Table I. shows the general careers of these graduates. Twenty-six, 5.7 per cent., have died, fifteen, 3.3 per cent., have retired from practise. Of the latter, nine are women who retired because of marriage. Only five men, 1.3 per cent. of the total number, have withdrawn from medical work. These figures are certainly in marked contrast to the forty per cent. of graduates supposed to have dropped out of practise under the old system of medical education.

Of the graduates now engaged in medicine 80 per cent. are in practise, 8.8 per cent. are engaged in teaching or scientific work and 2.2 per cent. in medical administrative work.

Tables II. and III. illustrate the specialization within the fields of practise and scientific work that has taken place. The percentage of graduates within each of these fields is shown. The data tabulated are based on the records published in the Johns Hopkins Circular and in the American Medical Directory. It is probable that the specialization is carried even further than here shown.

Specialization carries with it in most cases, and should in all cases, special training beyond that offered in the medical school. Table IV. shows the number of graduates in each of the main subgroups and the percentage of graduates in each of these groups whose records show special training subsequent to graduation. These records, as published in the Johns Hopkins Circular, are necessarily incomplete and undoubtedly represent far less than the total amount of postgraduate work and study. In the third column the percentage is shown of the graduates of each group who took a hospital interneship of one or more years, in the fourth column the percentage of those taking an interneship of two or more years, in the fifth column the percentage of those who took laboratory work but not a clinical interneship, in the sixth column the percentage of those whose postgraduate work was confined to graduate study, in the seventh column the percentage of those whose records indicate no formal work subsequent to graduation, and in the eighth column the percentage of those who took an interneship at the Johns Hopkins Hospital. Since these last interneships are open to students in the order of their class standings, the percentage of those in a group accepting them indicates the general scholarship of the group, although some of the best students in each class take work elsewhere.

From this table it may be seen that the 81 graduates now in general practise whose records shows no specialization belonged to the group with a relatively low grade of scholarship as undergraduates and with

TABLE IV

Special Training after Graduation

(J. H. U. Graduates, 1897–1906)

1	2	3	4	5	6	7	8
Group	Number in Group	Hospital Internship at Least One Year	Further Residence Training	Laboratory Work Only	Graduate Work Only	Special Training not Specified	J.H.H. Internes
		% of Group	% of Group	% of Group	% of Group	% of Group	% of Group
General practise without specialization	81	63	34.6	3.7	1.2	32.1	16
General practise with specialization	75	80	56	6.7	1.3	12	17.4
Total general practise	156	71.2	44.9	5.1	1.3	22.4	16.9
Internists	35	77.1	62.9	14.5	2.9	5.8	42.9
Pediatrists	11	72.7	63.6	18.2	9.1		18.2
Neurologists	8	75	75	12.5		12.5	0 (37.5% Disp.)
Dermatologists	6	33.3	16.7		66.7		0 (66.7% Disp.)
Laboratory diagnosis	16	25	6.3	75			0
Total medicine	76	61.9	48.77	25	9.2	3.9	22.4
General surgery	58	87.9	74.1	7	1.7	3.4	46.6
Gynecology	14	85.7	57.1	7.1		7.1	71.4
Orthopedics	10	100	60				50
Genito-urinary	12	75	58.3		8.3	16.6	33.3
Eye, ear, nose, etc.	19	58	21	5.3	26.3	10.5	10.5
Obstetrics	20	90	80			10	55
Total surgery	133	83.5	63.2	4.5	5.3	6.8	44.4
Science teachers	40	50	15	50			42.5
Hospital superintendents	5	100	100				0
Public health officers	4	75	25	25			0
Others	1			100			0
Total	415	71.6	48.9	13	4	11.3	29

the least training after graduation, 32.1 per cent. giving no record of such training.

The 75 graduates in general practise who are specializing to a greater or less extent, on the other hand, show but 12 per cent. without interneship or some other form of postgraduate training.

The 76 graduates in the group of specialists in internal medicine show but 3.9 per cent. without special postgraduate training, although in this group laboratory work, chiefly in pathology, has been to a considerable extent substituted for clinical interneships. The two men of the group who now hold the chairs of medicine at Harvard and Columbia, respectively, had a postgraduate training largely in pathology. The internists show a high percentage of Johns Hopkins Hospital interneships while the neurologists and dermatologists have depended more on dispensary training, a third of the first group and two thirds of the second having had work at the Johns Hopkins Hospital Dispensary.

The 133 graduates who have specialized in general surgery and its various branches show a high record of undergraduate scholarship as evinced by the high percentage of Johns Hopkins Hospital interneship, and few, only 6.8 per cent., without records of special postgraduate work, chiefly interneships. The length of time spent by many of these surgeons as internes and residents in hospitals is considerable.

Thus the total resident hospital service spent by the 22 general surgeons who received one or more years of their hospital training at the Johns Hopkins was 98 years, an average of 4½ years. That of 8 gynecologists with similar training was 37 years, likewise an average of about 4½ years, while that of 11 obstetricians was 39 years, an average of about 3½ years. The length of service of different individuals varied in surgery from 2 to 8 years, in gynecology from 3 to 7 years and in obstetrics from 2 to 5 years.

With this long hospital service of graduates preparing for surgery may be compared the services of a similar group of 13 men preparing for internal medicine. These men served a total of 50 years, an average of nearly four years, with variations in length of service from 2 to 10 years.

Of the graduates in the surgical group those whose records show the smallest percentage of specialized graduate training belong to the genito-urinary surgeons and the eye, ear, nose and throat specialists. These men undoubtedly have for the most part had a large amount of dispensary training not indicated in the records.

The 40 graduates included in the science group all had, as assistants and young instructors, a large amount of special laboratory training subsequent to graduation. Yet 50 per cent. of them first spent a year or more as clinical internes.

The 10 men now engaged in administrative work all had some special postgraduate training, in most cases including a hospital interneship.

The long course of preparation, four years in college, four years in the medical school and several years of subsequent training for a specialty which marks the career of so large a percentage of those under consideration would lead us to expect to find most of them settled in large centers of population where specialists have the best opportunity to exercise their calling and get return from the heavy investment in time and money. This is the case. The graduates of the first ten classes are widely scattered over the country from Maine to California and from Minnesota to Louisiana but for the most part they are settled in large cities, Baltimore naturally claiming the lion's share, but with a relatively large number in New York, Boston, St. Louis and San Francisco.

TABLE V

Location According to Size of Towns

J. H. U. Graduates, 1897–1906, Practitioners Only

Population of Residence	Total No.	Women	First 5 Classes	Second 5 Classes
	329	33	108	221
1,000,000+	9.4%	15.2%	10.2%	9 %
400,000+	30.7	15.2	29.6	31.2
200,000+	16.7	18.2	19.4	15.4
100,000+	11.5	9.1	16.7	9.1
50,000+	10.9	9.1	7.4	12.7
20,000+	6.4	15.2	6.5	6.3
10,000+		6.1	2.8	4.5
5,000+	6.7	3	2.8	2.77
5,000−	6.4	6.1	1.9	8.6
Foreign	1	3	2.8	0.5

Table V. shows the distribution of the graduates engaged in private practise in this country and its dependencies, marked "foreign" in the table, according to the size of the communities in which they are located. From this it may be seen that over two thirds are located in cities of 100,000 inhabitants or over, and relatively few are located in towns of 10,000 inhabitants or less.

The great majority, therefore, are in active competition with first-class men in large centers. How many have made a striking success? This is a difficult matter about which to form a fair judgment. Excellent service may lead to a merely local

reputation while the ability of a mediocre man to get articles into popular weeklies or into the newspaper may lead to inclusion in "Who's Who." In order, however, to get some measure of success I have tabulated (Table VI.) the percentage of those

TABLE VI

Societies and Distinctions

(J. H. U. Graduates, 1897–1906)

Group	Number in Group	Fellows A. M. A., %	Members Spec. Soc., %	Fellows A. C. S., %	Who's Who, %	American Men of Science, %	Starred Individuals, %
General practise without specialization	81	54.3	6.2	0	2.5	2.5	
General practise with specialization	75	72	5.3	0	1.3	4	
Internists	35	91.5	48.6	0	28.6	22.9	2.9
Medical specialties	41	80.5	43.9	0	2.4	14.6	
Total medical	76	85.5	46	0	14.5	18.4	1.3
General surgery	58	88	27.6	60.4	5.2	5.2	1.7
Surgical specialties	36	83.4	47.3	50	8.3	2.8	
Eye, ear, nose, throat	19	89.5	31.6	42.1	5.3	10.5	
Obstetrics	20	80	15	35	5		
Total surgical	133	85.7	31.6	51.9	6	4.5	0.8
Science	40	57.5	82.5		52.5	75	30
Administration	10	50					
Total	415	73.5	28.8	16.6	10.4	13.3	3.4

belonging to various special groups who have been made members of special scientific medical societies, of those who have been included in "Who's Who," and in "American Men of Science," with a special column for those starred as among the first 1,000 men of science. Since the last edition of "American Men of Science" was published in 1910 the scientific standing of the members of the later classes to graduate is not up-to-date. For the sake of comparison I have also shown the percentage of each group who are fellows of the American Medical Association and I have included a special column to show the Fellows of the American College of Surgeons.

The graduates who have taken up a career in science show the greatest percentage of those included in "Who's Who" (52.5 per cent.) as well as in "American Men of Science" (75 per cent.) and in the starred list (30 per cent.). The internists come next (28.6 per cent. in "Who's Who") while relatively few of the surgeons are thus distinguished (6 per cent.). The surgeons represent, on the whole, the strong students with a practical rather than a scientific attitude of mind, while the internists represent a group of strong men with both "practical" and scientific leaning. Taking the whole group of 415 individuals now engaged in medicine we find 10.4 per cent. included in "Who's Who," 13.3 per cent. among "American Men of Science" and 3.4 per cent. among the starred individuals.

For the sake of comparison the following rough estimate[3] may be of interest:

[3] These estimates, necessarily rough, are based on the following data. The population of the country is taken as 100,000,000. The number of males of a given age is based on the ratios given in the last United States census reports. The number of college graduates is based on the ratio between academic and medical students during the last quarter of the nineteenth century and on the assumption that the ratio between the number of living individuals with the M.D. and of those with the bachelor's degree corresponds with this ratio but with somewhat fewer students finishing the academic than the medical course. This gives as a rough estimate 500,000 college graduates, a number probably too high if graduates of regular college courses of the old type are alone counted, too low if the graduates of all sorts of technical courses leading to the bachelor's degree are counted. It is arbitrarily assumed that of the 500,000 graduates, 350,000 are men and the ratios used in estimating the general male population of a given age are used in determining the number of college graduates of a given age, the age of twenty-two being taken as the minimum

TABLE VII.

Adult Males	Est. Number	Per Cent. in Who's Who	Per Cent. in American Men of Science	Starred List
30–39 years of age...	7,700,000	0.029	.015	.003
40–49 years of age...	5,600,000	0.77	.04	.008
Male college graduates:				
30–39 years of age..	91,000	1.18	1.1	.24
40–49 years of age..	65,800	3.2	2.8	.6
Physicians, men:				
30–39 years of age..	44,000	.41	0.8	.15
40–49 years of age..	32,000	1.1	0.8	.15
Second five classes:				
Living men.....	254	3.9	9.1	1.2
First five classes:				
Living men.....	125	25.6	25.6	8.8
Both classes	379	11.1	14.5	3.7

age of those graduates. The number of physicians is estimated from the numbers given in the last edition of the American Medical Directory, an arbitrary allowance of 2½ per cent. being made for women physicians. The number of physicians of a given age is estimated like that of college students but twenty-five is taken for the minimum age. The estimates of the Johns Hopkins graduates are based on actual figures. The numbers of those given in "Who's Who" are taken from the last edition but the age ratio and sex ratios are taken from data given in the 1903–05 edition. The estimates of those included in "American Men of Science" are based on the figures 5,536 for all individuals and 1,201 for starred individuals (269 names being added to the list of 1,000 in the first edition and 68 removed). The age ratios for the thousand leading men given by Cattell in the last edition are used for estimating the number of individuals of a given age in both lists. Since the age of the leading men tends to be higher than that of those not attaining distinction, this method of estimating probably gives figures smaller than the actual figures for those merely included in the total list and possibly also for those who make up the 200 starred individuals in excess of the 1,000 on which Cattell bases his estimates. Since, however, no allowance has been made for the two or three per cent. of women in the lists and for Canadians in the first list, it is probable that the estimates used give sufficiently accurate results for our present purposes. Cattell in his statistical tables shows at what institutions 515 of the first thousand men of science received their bachelor's degree but he does not give figures showing the number not receiving a bachelor's degree. Pearse in his analysis of the medical group (SCIENCE, XLII., p. 277, 1915) shows that about 22 per cent. of those contributing to the medical sciences took no bachelor's degree, although many of these did some college work. Since this group compared with other groups contains a high percentage of investigators who took no bachelor's degree we may take 15 per cent. as an arbitrary proportion in estimating the number of such men and this has been done in estimating the percentage of college graduates included in "American Men of Science" and among the starred individuals. Test counts supported those estimates. The age ratios are estimated as given above. Scott Nearing has recently made a study of 2,000 men in "Who's Who" of about the age of those here studied. *Scientific Monthly*, January, 1916.

Since relatively few women are included in "Who's Who" and in "American Men of Science" and only one of the fifty-one living women graduates in our list, we can get the best idea of the relative distinction indicated by inclusion in these two lists by comparing the percentage of men graduates included in these lists with the percentage of other men of similar age thus included. The average age of the men of the first five classes may be taken for "Who's Who" to be from about 40 to 45 years of age and of those included in "American Men of Science" from about 35 to 40 years of age. The average age of those of the second five classes may be taken to be about five years less. Without going here into detail we may say the percentage of graduates of the second five classes included in these lists is about ten times as great as would be expected from them as physicians and from nearly four to eight times as great as would be expected from them as college graduates. The percentage of those of the first five classes included in the lists is from twenty-three to nearly sixty times as great as would be expected from them as physicians and from eight to fifteen times as great as

TABLE VIII

Relation of Preliminary Training to Careers (J. H. U. Graduates, 1897–1906)

	Total No	Special Groups			Honors			
		Medicine, Per Cent.	Surgery, Per Cent.	Science, Per Cent.	W. W., Per Cent.	Science, Per Cent.	Science Starred, Per Cent.	A. C. S., Per Cent.
New England colleges for men:								
Yale	50	22	36	10	14	18	2	26
Bowdoin	11	9	27.3	9	0	0	0	0
Harvard	11	18.2	18.2	27.3	27.3	27.3	9	9
Amherst	9	11.1	66.6	0	11.1	11.1	0	44.4
Williams	7	14.3	47.2	0	14.3	0	0	42.9
5 others	11	9	54.5	0	0	0	0	9
Total	99	17.1	39.4	9.1	12.1	13.1	2	21.2
Eastern colleges for women:								
Smith	8	0	25	12.5	12.5	12.5	12.5	0
Wellesley	8	12.5	0	0	0	0	0	0
4 others	8	37.5	0	0	0	0	0	0
Total	24	16.5	12.4	4.1	4.1	4.1	4.1	0
North Atlantic:								
Johns Hopkins	67	27	29.9	13.4	14.9	19.4	3	17.9
Princeton	17	5.9	59	0	0	5.9	0	47
Cornell	8	12.5	62.5	0	0	0	0	0
20 others	39	10.3	30.8	2.6	0	2.6	0	20.5
Total	131	18.3	35.9	7.6	7.6	11.5	1.5	21.4
Middle West:								
Wisconsin	22	36.4	22.8	13.6	9.1	18.2	4.6	9.1
Knox	6	16.7	33.3	0	16.7	33.3	0	16.7
Michigan	5	0	20	80	60	60	40	0
Chicago	5	20	20	20	40	60	20	20
Adelbert	3	0	33.3	33.3	33.3	33.3	33.3	33.3
26 others	30	9.9	33.3	9.9	0	6.7	0	16
Total	71	18.3	28.2	16.9	12.7	21.2	7.1	14.1
Far West:								
Stanford	17	5.9	35.4	0	0	5.9	0	0
California	11	18.2	27.3	18.2	18.2	27.3	9	18.2
Total	28	10.7	32.1	7.1	7.1	14.3	3.6	7.1
South:								
Randolph Macon	10	10	40	10	30	10	10	20
N. Carolina	8	25	0	12.5	0	12.5	0	0
Georgia	5	40	40	0	20	0	0	0
Kentucky	5	40	20	20	40	20	20	0
Hamp. Sidney	4	25	25	0	25	0	0	25
19 others	28	25	25	7.7	3.6	10.7	0	14.3
Total	60	25	25	8.3	13.3	10	3.3	11.7
Canada	2	0	0	50	50	50	50	0
Totals	415	16.3	32	9.6	10.4	13.3	3.4	16.6

would be expected from them as college graduates. I have no data with which to compare them with other college men who have taken the medical course elsewhere. It is obvious, however, that an unusual percentage of the men under consideration have attained the kind of distinction which gives one a place in "Who's Who" and in "American Men of Science" and may be looked upon as among the leaders in their chosen fields. Of the graduates of the first two classes about one in three is in-

cluded in "Who's Who," four out of the fifteen in the first graduating class are in the starred list in "American Men of Science."

The relation of ultimate success to premedical college training is of some interest. While I have not time to go into this subject at present in any detail, I may point out in Table VIII. that students coming from the colleges of the Middle West have been particularly strong in science while those from the colleges of the North Atlantic States have been strong in practical surgery but have not gone much into research or other fields leading to a more or less national distinction. It is only by putting the graduates of the collegiate department of the Johns Hopkins in the North Atlantic division that this division is enabled to make a fair showing outside of surgery as compared with the other divisions. Based on its clientele this department might perhaps more justly be placed in the Southern division. Some points brought out by the table are difficult to explain. Why, for instance, should the graduates of the University of California make an unusually good showing from the point of view under discussion and those of Leland Stanford an unusually poor one? Why should the smaller colleges of the South do so much better on the whole than those of the small colleges of the rest of the country?

From the records of the graduates of these first ten classes of the Johns Hopkins Medical School it is clear that their success along orthodox lines has been unusually high. Into this success numerous factors have entered which we need not discuss here but not all of which can we hope to have generally repeated with the elevation of entrance standards and reorganization of methods in the medical schools throughout the country. It is evident, however, that this general reorganization is accompanied by greater scientific productivity in medicine and a greater tendency to specialization than we have hitherto had in this country, accompanied by an increased tendency to settle in large cities. What lessons can we learn from this group of graduates who represent in a way the first product of our present methods of medical education and what deductions can we make as to the directions in which we should guide medical education so as to provide adequately for a generation ahead.

The aim in requiring premedical college training in physics, chemistry and biology and in greatly strengthening the laboratory work in the basal medical sciences has been to qualify men to bring the whole force of modern science to bear on the solution of medical problems. As a matter of fact the main point of view presented to and accepted by the majority of the group of students under consideration when they came to clinical problems was what we may designate as a "looking backward" point of view. The basis on which to found conceptions of a given disease was that of its ultimate ravages in a body incompetent to resist. The course of the disease was to a considerable extent reasoned out from the findings in the autopsy room. Most of the cases seen in the hospital wards were patients in whom disease was far advanced so that the autopsy picture of similar cases was an aid in formulating a picture of the probable appearance of the organs. Even in the dispensaries a large proportion of the patients were advanced cases. Little or no opportunity was given to study the beginnings of disease and the conditions in the individual or the community which produce these beginnings, although, of course, opportunity was given to study specific microorganisms and lectures were given on etiology. Few of the group of graduates

under consideration have gone effectively into the fields of hygiene and preventive medicine, although two have achieved distinction along these lines and one has a world-wide reputation for his work in the Far East and the Near East.

The medicine of the future is certainly to become more and more concerned with the prevention of disease or with the prevention of the spread of disease not only in the community but in the individual and relatively less concerned with its ultimate ravages. Means must be devised for bringing the student in contact with disease in its incipiency both in the community and in the individual and to give a "looking forward" rather than a "looking backward" point of view, opportunity to think of disease in terms of its earliest beginnings and gradual spread, rather than merely to deduce its course from its ravages. The detection of the earliest symptoms requires far more highly trained powers of clinical observation and far more highly skilled laboratory work than does the detection of disease in its later stages. We now expect tuberculosis to be detected before large cavities have appeared or even before the specific bacilli are found in the sputum but how many physicians can do so? The field that lies between chemistry, bacteriology and clinical medicine has been greatly developed since the men we have been considering above received their undergraduate clinical training and offers great help. Modern roentgenology is also of help in early diagnosis. But the undergraduates of to-day will not get opportunity to have practical experience in cultivating these fields if abundant opportunity is not given them for coming into contact with patients in the earliest stages of disease. For this consultation and diagnostic centers, such as have been urged by insurance companies, will have to be extensively established and placed at the disposal of our clinical teachers. To encourage this the public will need some education but there is a greater demand for such centers, I think, than is understood by the medical profession. The need of preventive dentistry has long been understood by the more intelligent classes in this country. Recent developments have shown that in the endeavor to save teeth some dentists have succeeded to the detriment of the general health of the patient and have served to emphasize the fact that specialists must cooperate for the ultimate best results to the patient.

Diagnostic centers used for medical teaching will probably have to be supported by public taxation or by endowments. Similar centers should be open to those who can afford to pay a moderate fee for the services of a group of specialists. Few can afford, or feel they can afford, to go to a series of specialists and pay the fees necessary to keep up a series of special establishments unless disease is so far advanced that the necessity seems imperative. With the development of opportunities to study disease in its incipiency optimistic therapy will more and more take the place of the therapeutic nihilism that haunts the autopsy room.

The development in Europe of social insurance and its beginnings in this country will make the importance of preventive medicine increasingly clear both to the organizers of industry and to industrial workers. Somewhere in the training of our students we must make them acquainted with modern industrial problems so that as physicians they may take a wise leadership in at least the medical aspects of the industrial reorganization which is taking place.

One mistake frequently made should, I think, be pointed out. No sharp line can be drawn between preventive medicine, on the one hand, and curative medicine, on

the other hand. Public health officers can not do thoroughly effective work if they can not apply remedies to diseased individuals as well as to other sources of danger to the public health. By far the most effective public health service in this country to-day is the United States Public Health Service and here treatment of individuals and treatment of environment are carried on hand in hand. The practising physician can not do effective work for his patients if he does not take an active part in promoting public health measures.

From the social standpoint two things in the practise of medicine especially need changing. First we need more organization and cooperation of men in different lines of work in place of the extreme individualism which prevails to-day and is economically so wasteful. Hospitals should be looked to more and more as natural centers where the specialized activities of groups of physicians may be brought into harmonious cooperation and where diagnostic centers for those who can afford to pay, as well as for the poor, may be established and economically run. Hospitals of this kind established in rural districts would do much to make the conditions of rural practise more attractive and to overcome the lack of physicians which in some communities is already serious and will become more so with the decrease in the number of physicians brought about by raising of standards of medical education. A greatly reduced number of physicians in this country can serve the needs of the people effectively only through cooperation. With cooperation it will be possible to serve the community far more effectively than before. It has been estimated for instance that at present in Wisconsin physicians attend women in labor in only 40 per cent. of cases, midwives, usually poorly trained, in 40 per cent. of cases, and no trained persons in 20 per cent. of cases. With the establishment of more hospitals and the use of automobiles practically all women might be given opportunity to bear children amid good surroundings and under skilled care, with untold good to the public. Rural nurses in connection with the rural hospitals and visiting nurses in connection with the city hospitals add greatly to their effectiveness.

Besides the need of more effective organization and cooperation there is a need of a reorganization in medical economics. The public should pay for the public services which physicians perform. The evil of extracting a large amount of service for little or nothing is especially marked in the large cities where young physicians are encouraged to do a large amount of dispensary work for "experience." The Robin Hood method of subsequently making the rich pay fees sufficient to cover the services rendered the poor is economically wrong. Public service should be paid for by the public to the medical as well as to the legal profession.

The expenses connected with the early years after graduation as well as the cost in time and money of the long training now demanded of medical students makes it imperative that we should seek to lessen the cost to the student in every way compatible with efficient training. Otherwise we shall limit the profession too much to a restricted class of the well-to-do. By making the relative proportion of the cost of the investment represented by a medical education unduly high to the student we shall encourage him subsequently to become commercialized, to forget that the public and teachers are stockholders in the investment and to make his chief aim in practise the greatest possible financial re-

turn to himself. With the profession confined to a few high-priced practitioners there will be danger of increased quackery for the mass of the people.

If we try to reduce expense by educating large numbers in relatively few medical centers, as seems to be advocated by those in charge of the investigations of medical education for the Carnegie Institutions, I believe that effective results will not be obtained because intimate association between teacher and pupil is necessary for effective training in a complex field like medicine and this becomes difficult or impossible when students are thought of in large masses rather than as individuals. Our schools with the largest endowments and best facilities are thus coming to limit the number of students received in each class. The tendency to encourage students to get the premedical work in academic colleges and the growing number of institutions giving the first half of the medical course show us ways of keeping the number of students taking the preliminary scientific training for clinical medicine restricted to relatively small groups the members of which can receive considerable individual attention. There are two chief difficulties at present connected with this part of the work. First, work in the preliminary sciences at the larger colleges and universities is given to such large classes and sections that individual instruction is hampered unless special sections with special instructors are provided for the premedical students. Second, the premedical work in the sciences is practically always given and the work in the fundamental medical sciences is to a greater or less extent given by men who have not had a medical education and are not intimately acquainted with medical problems. While the fundamental sciences should be taught from a broad point of view and not be restricted to a special aspect thought by the teacher to be all that is necessary for medicine, the training in the basal sciences should be such as to fit the student as simply and directly as possible to view medical problems from the point of view of physics, chemistry and biology and the more specialized sciences. That medicine can be thus viewed from these various points of view will be best appreciated by the student if he is thrown with teachers capable of doing so. Those who administer preclinical courses should keep this fact in mind. If it is kept in mind there is no reason why there should not be gradually established in the country a considerable number of effective preclinical courses where the student can get an effective training for clinical work. Compared with ordinary college courses such courses will be expensive but viewed from the standpoint of their value to society they should be of great value.

The clinical part of medical training presents a more difficult problem. At present the tendency is to devote about one third of the second year and all of the third and fourth years of the four-year medical course, and an interne year to clinical training. The premedical and preclinical medical work takes up the major part of our ordinary four-year academic college course. In addition we require three further years of clinical study, as much time as is required of a college graduate for a Ph.D. degree. The graduate student has opportunities for teaching fellowships sufficient to cover at least the cost of living. The medical student is required to pay large tuition fees in addition to his living expenses except during the interne year when he is relieved of the tuition fee and gets room and board for his services

to the hospital. Students are encouraged to believe that they can get adequate clinical training only in large cities and that the most valuable interneships are in the larger hospitals in these cities. Clinical teaching thus becomes to a large extent mass instruction. Intimate relations between individual students and individual teachers become difficult even during the interne year.

The old apprenticeship system in medical education had some marked advantages which present system of mass instruction lacks. Is it not possible to restore some of the advantages of the old apprenticeship system without loss of modern scientific training? Can we not utilize a large number of clinical centers for clinical teaching and a large number of progressive men as teachers instead of restricting clinical teaching to a few men connected with large hospitals adjacent to medical schools in large cities?

I believe this can be brought about by encouraging a greater number of practising physicians to qualify for the term doctor in its original sense of teacher. Why should not our medical students after two years of premedical college work and two or three years in the medical school be qualified to reside in hospitals, for the most part small hospitals, where they could earn board and room by helpful work about the place and at the same time study under the immediate supervision of members of the hospital staff. Such hospitals should provide diagnostic centers along the lines outlined above. If a few students thus acted as clinical clerks in a series of hospitals during the course of two or three years following the present second or third year in the medical school they could get a broad experience in direct contact with medicine as it is best practised at the present time. Variations in the types of hospitals would secure training in the varied lines of medicine. Each student would come in intimate contact with a considerable number of active progressive men whom he would stimulate and some of whom would in turn inspire. Only hospitals of a certain grade would be recognized for this service and this in turn would serve to stimulate hospital development. The immediate clinical facilities of the medical school could be utilized for supplementing and strengthening the extra-mural hospital service and the clinical staff would have supervision of the clinical teaching in the hospitals and give the final examinations. The expenses of the medical course would be reduced and the public would profit from a more direct training of its practitioners. Furthermore, this system would help to overcome one of the greatest dangers of our present system of education, the destruction of originality through too many years of subordination of personality to mass domination by teachers. It would tend to produce independence in the students.

Such a plan may not, of course, be best for all schools but it may for some. As an association let us maintain the scientific ideal in medicine but let us not carry standardization too far. Let us encourage different methods of reaching the results at which we all should aim, the establishment in our students of habits of independent accurate observation, of judgment based on knowledge of fundamentals and of skilled execution based on practical experience, and then let us study the results as scientifically as possible and base our changes in methods so far as we can on observed facts.

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THE FOREST SERVICE

The annual report of the forester of the Department of Agriculture made public on

December 21 comments on the government ownership of water-power sites and timber as exemplified by the national forest system. The financial burdens resting on private owners of uncut timber are held to have forced the manufacture of lumber without regard to market demands, and with consequent demoralization of the lumber industry and wasteful use of timber resources; while facts and figures regarding the water power situation are given to prove that more rapid development of water power in the west is mainly prevented by the lack of consumers, rather than by the absence of suitable legislation.

Water power permits taken out for National Forest projects, says the report, involve a total of 1,261,560 horsepower. Free permits cover 70,628 horsepower and the plants actually constructed or operating June 30 had an output capacity of 341,276 horsepower, the rentals paying $89,000 during the year. The report comments on the water power situation as follows:

New legislation permitting the government to grant a more secure tenure for the lands used, through the issuance of fifty-year leases, would, without doubt, make the financing of power developments on the public lands both easier and cheaper, and is very desirable; but the main obstacle to more rapid development than that which is now taking place is not lack of a new law but lack of a broader market for power. It is at least doubtful if either an amended law or private ownership of the public power sites would result in any general or material increase in power development in the western states in the immediate future. With rare and minor exceptions, existing power developments in these states are far in excess of market demands. The Forest Service is being constantly importuned to extend periods of construction on power permits on the plea that there would be no market available for the power if the project were developed. The per capita use of water power in electrical development in the three Pacific and the eight Mountain states is far in excess of that in any other section of the United States, and more than five times the average for the United States, as a whole. The development of the Pacific States is about 180 horsepower, per thousand of population, and in the Mountain states 120 horsepower, with a balanced average of 160 horsepower. New England, which is next in order, has less than 40 horsepower per thousand of population, and the whole United States about 30 horsepower.

The report goes on to say:

The drop of thirty per cent. in the demands for national forest stumpage, as indicated by the falling off in new sales, is a significant index of the unstable market for lumber and the serious conditions now obtaining in the forest-using industries.

These conditions which are now the subject of a special study conducted by the Department of Agriculture in cooperation with the Federal Trade Commission and the Bureau of Foreign and Domestic Commerce

are related primarily to the carrying of enormous quantities of raw material, exploitable only during a long period of time, in private ownership. This load of uncut timber, with its far-reaching financial burdens, hampers or prevents the private operator from adapting his business to the changed conditions of his market and to the competitive factors of more or less recent development. Hence a tendency toward a lumber output governed not by the requirements of the country, but by the financial necessities of the owners of stumpage, with its resultant market demoralization and wasteful use of timber resources. Had the national forests never been created, the conditions of trade depression and wasteful exploitation, detrimental alike to the interests of the lumber industry and the public, would have been markedly accentuated. The value of public ownership of a considerable part of the timber resources of the nation has never been demonstrated more strikingly than by the results of private ownership now manifest.

Although large commercial sales fell off, due to the depressed condition of the lumber market, says the report, the number of sales to settlers, farmers and small dealers at cost rates nearly doubled in number, while more than 40,000 free timber permits were issued, an increase of 549. The steady increase of this use, the forester adds, indicates the importance of the national forests to the communities in which they lie and the stability of the local demand for their products.

The report discusses in detail the work of the Forest Service during the fiscal year ended June 30 last, showing a general increase

in all forest activities except commercial timber sales. It predicts, however, a large revenue from all sources for the fiscal year 1916, the general improvement in business conditions throughout the country having been already felt in the national forests, as shown by an increase during the first three months of about $119,000 over the earnings of the same period last year. During the fiscal year, the total revenues were $2,481,469.35, an increase of $43,759.14 over 1914. Of the $5,662,094.13 provided by the regular appropriation for the Forest Service, says the report, $5,281,000 was expended for protection, utilization and improvements, the cost of protection being increased by an extraordinarily severe fire season which necessitated emergency expenditures that were partly provided for by a deficiency appropriation of $349,243. An additional sum of about $196,000 was spent under the law which permits 10 per cent. of the forest receipts to be employed in road development for the public benefit.

The expenditures include, says the report, the protection of resources which as yet can not be made to bring in cash returns, such as inaccessible timber, as well as those, such as watershed covering and recreational advantages, which yield great general benefits not, however, measurable in money values. In this connection, the report mentions that timber given free to settlers and others was worth more than $206,000, while that sold under the law at cost was worth $33,000 more than the government got for it. The revenue also foregone by allowing free use of certain grazing lands, adds the report, is estimated to exceed $120,000, while a moderate charge for privileges that are free would bring in at least $100,000 more. All this, says the forester, has never been entered on the credit side of the Forest Service ledger.

SOIL SCIENCE

Soil Science is the title of a new monthly journal which is published under the auspices of Rutgers College. The journal, which is international in its scope, is devoted exclusively to problems in soils, including soil physics, soil chemistry and soil biology. Dr. Jacob G. Lipman, of the New Jersey Agricultural Experiment Station, is editor-in-chief, and has associated with him a consulting international board of soil investigators. This group consists of twelve of the leading authorities on soils in the United States and eleven from foreign countries.

It is believed that the journal will fill a distinct need in the field of modern science. Soil investigators have long felt the necessity for a specific medium for the publication of their research work. Heretofore, they have found it necessary to resort to journals not specifically devoted to soil problems. Consequently, they have been put to much inconvenience in keeping before them all the more important papers in soil research. Moreover, they have found it increasingly difficult to secure the prompt publication of their own papers in journals whose contributions cover a wide range of scientific activity. In planning for the publication of *Soil Science*, the editor was guided by the wish to facilitate the bringing to light of the results of soil research. He felt encouraged to believe that the new journal would help to conserve the time and the energies of his fellow students of soils, that it would provide for a more direct contact among men interested in the same problems, and that it would lead to a broader outlook on the entire field of soil fertility.

THE ECOLOGICAL SOCIETY OF AMERICA

A meeting of ecologists was held at Columbus in convocation week to take action upon the proposal made at the Philadelphia meeting for the formation of a society of ecologists. Over fifty persons were present and the organization committee held letters from about fifty others who expressed interest in the project. In view of these facts it was unanimously voted to organize under the name The Ecological Society of America. It was decided to enroll as charter members not only those present at the organization, but also those who had by letter expressed a desire to be included in the membership, as well as those joining prior

to April 1, 1916. A constitution which had been drafted by the organization committee was adopted, and the following officers were elected: President, Professor V. E. Shelford, of the University of Illinois; vice-president, Professor W. M. Wheeler, of Harvard University; secretary-treasurer, Dr. Forrest Shreve, of the Desert Laboratory. The first regular annual meeting will be held in New York during the next convocation week, where a program will be arranged in harmony with the programs of other societies, so as to minimize serious conflict. Frequent field meetings will be held under the auspices of the society—four having already been arranged for the coming summer. Several proposals for the carrying out of cooperative investigations are also being entertained by the members of the society.

SCIENTIFIC NOTES AND NEWS

A BANQUET will be held in commemoration of the one hundredth anniversary of the organization of the United States Coast and Geodetic Survey on April 6, at the new Willard Hotel, Washington, D. C. The speakers will be: the President of the United States, the Swiss minister, the secretary of the navy, the secretary of commerce and Dr. Thomas Corwin Mendenhall.

THE American Chemical Society will hold its annual session at the University of Illinois from April 17 to 21. On April 19, in connection with these sessions, the new chemistry building of the university will be dedicated. The equipment for the new laboratory is arriving daily and is being installed as rapidly as possible to facilitate the preparation for the dedication of the building. At the dedication exercises Governor Edward F. Dunne will preside and deliver an address. Other addresses will be given by Dr. W. R. Whitney, of the General Electric Company and a member of the U. S. Naval Board, and Professor Alexander Smith, of Columbia University, by President James and others.

DR. L. O. HOWARD, chief of the Bureau of Entomology, U. S. Department of Agriculture, will give the evening lecture at the general meeting of the American Philosophical Society, on the evening of April 14. The subject will be "On Some Disease-bearing Insects."

THE Avogadro Medal has been awarded to Professor H. N. Morse, of the Johns Hopkins University, for the most important contribution to molecular physics made since the meeting held in Turin in 1911, to celebrate the centennial of the announcement of the hypothesis of Avogadro.

THE Illinois Academy of Science has elected the following officers for the ensuing year: *President,* Dr. William B. Trelease, head of the department of botany, University of Illinois; *Vice-president,* Dr. Griffith, of Knox College; *Secretary,* Dr. J. L. Pricer, of Normal University; *Treasurer,* Dr. H. S. Pepoon, of the Lakeview High School of Chicago.

DR. KARL SCHWARZSCHILDT, director of the Astrophysical Observatory at Potsdam, has been given an honorary professorship in the University of Berlin.

PROFESSOR KARL GRAEBE, professor of chemistry at Geneva from 1898 to 1910, discoverer with Liebemann of artificial alizarin, has celebrated his seventy-fifth birthday.

PROFESSOR O. C. GLASER has been appointed director of the Biological Station of the University of Michigan.

THE Associated Geological Engineers have opened a New York office in charge of Frederick G. Clapp, managing geologist of the petroleum division.

THE University of Toronto has granted Velyien E. Henderson, associate professor of pharmacy and pharmacology, leave of absence on his appointment as major in Canadian overseas expeditionary force.

DR. E. W. OLIVE, curator at the Brooklyn Botanic Garden, sailed on February 19 for Porto Rico to study and collect parasitic fungi and other plants.

MR. AND MRS. ROY CHAPMAN ANDREWS are leaving on an expedition to southern China to make collections of mammals for the American Museum of Natural History.

The Washington Academy of Sciences has arranged a series of evening lectures dealing with various phases of the war. On March 2, Dr. Douglas W. Johnson, of Columbia University, addressed the academy on "Surface Features of Europe as a Factor in the War." The second lecture of the series, entitled "Chemistry in Relation to the War," will be presented by Dr. L. H. Baekeland on March 23. Through the courtesy of the secretary of the Smithsonian Institution the large auditorium of the new National Museum has been placed at the disposal of the academy for this series of lectures.

President Charles R. Van Hise, of the University of Wisconsin, gives the Sigma Xi address at the University of Minnesota on March 17.

On February 25, Professor George Grant MacCurdy lectured at Bryn Mawr College on "The Origin and Evolution of Ornament in Art."

Dr. Vera Danchakoff, of the Rockefeller Institute, addressed the seminar in zoology of the University of Pennsylvania, on February 29, on the subject of "Experimental Modification of Hematopoiesis in the Chick Embryo."

Dr. Herbert V. Neal, professor of zoology at Tufts, is giving a series of lectures on "The Organic Evolution of Life" in Tremont Temple, during March and April.

Dr. Willis T. Lee, of the United States Geological Survey, will give an illustrated lecture on April 7 at Lehigh University on "Camp Life of a Geologist in the Rocky Mountains."

A course of five lectures, with accompanying laboratory demonstrations, was given by Dr. Fred. E. Wright, petrologist, Geophysical Laboratory, Carnegie Institution of Washington, before the Department of Geology of Columbia University from February 28 to March 3. Dr. Edgar T. Wherry, of the United States National Museum, gave before the department on March 8, two lectures on petrographic methods.

During the coming summer session of the University of California, from June 26 to August 5, three graduate seminars will be offered in the department of chemistry: "Recent Theories Concerning the Nature of Free Radicals, Oxonium and Carbonium Salts," Professor M. Gomberg, of the University of Michigan; "Colloids and Surface Tension," Professor J. H. Hildebrand; "The Calculation of Free Energy," Professor G. N. Lewis.

Dr. William L. Rodman, this year president of the American Medical Association, professor of surgery at the Medico-Chirurgical College of Philadelphia, died on March 8, aged fifty-eight years.

UNIVERSITY AND EDUCATIONAL NEWS

In the will of Robert R. Rhodes, of Cleveland, Western Reserve University, through its medical school and affiliated institutions, is a beneficiary to the amount of about half a million dollars. There was given to Lakeside Hospital, $250,000; to Charity Hospital, $50,000; to St. Alexis Hospital, $50,000; to the School of Medicine, $50,000; to the Babies' Dispensary and Hospital, $25,000; to the Tuberculosis Free Dispensary, $25,000, and to the Maternity Hospital, $25,000.

The will of Marie Antoinette Fisk, of Pasadena, Cal., gives $50,000 to Princeton University for the construction or improvement of dormitories.

Fire on March 5 completely destroyed the new engineering building and shop buildings of the Michigan Agricultural College at East Lansing, with a loss of about $240,000. Most of the engineering, shop and physics equipment was lost, as were also the records, notes and libraries of the teaching staff.

Miss Sarah Holborn has bequeathed £1,000 to the London School of Medicine for Women.

We learn from *Nature* that a friend of the late Dr. Donaldson, master of Magdalen College, Cambridge, has endowed a bye-fellowship of the annual value of £100, to be called the Donaldson Bye-Fellowship, in memory of the late master; the fellowship is intended for the

encouragement of research, and is tenable for one year. The financial board reports that Sir Eustace Gurney has offered to present to the university a farming estate of about 257 acres with a view to the encouragement of the study of forestry in the university; the net income in rent of the estate is about £100 per annum. The general board of studies reports that the council of the Royal Geographical Society has decided to make grants of £300 per annum for five years to the schools of geography in Oxford and Cambridge.

THE trustees of Columbia University have voted to admit women to the College of Physicians and Surgeons.

ELMER GEORGE PETERSON, A.M., Ph.D. (Cornell), was elected president of the Utah Agricultural College, on March 17.

DR. ROSWELL C. MCCREA, dean of the Wharton School and professor of economics in the University of Pennsylvania, has accepted a professorship of economics in Columbia University.

AT the University of Cambridge Mr. H. H. Brindley, of St. John's College, has been appointed demonstrator of biology to medical students, and Mr. C. Warburton, of Christ's College, demonstrator in medical entomology.

DISCUSSION AND CORRESPONDENCE

"SCIENTIFIC AND APPLIED PHARMACOGNOSY"

TO THE EDITOR OF SCIENCE: Since the publication of my review of Professor Henry Kraemer's "Scientific and Applied Pharmacognosy," which was written at your request, I have received a letter from my Philadelphia colleague charging me with misrepresentation and other acts of unkindness. In reply I informed him that I was exceedingly sorry to learn that I had offended him and begged him to inform me where I had erred. This he has done in a second letter. I should be glad to have you give the readers of SCIENCE an opportunity to judge for themselves if I have been guilty of misrepresentation, even though quite unintentionally.

One of my statements to which Professor Kraemer makes objections is the reference to failure to give credit to Tschirch's "Handbuch der Pharmacognosie" in his preface, viz.:

> One point, however, is noteworthy as a curious omission. Among the works consulted, the author in his preface does not even mention Tschirch, or his predecessors Flueckiger and Hanbury.

The part of the preface to which I had reference reads as follows:

> In the preparation of a book like the present it is self-evident that it is based upon the work of the great masters who have developed pharmacognosy from its inception. Among the works consulted by the author, and of which special mention should be made, are the following: . . .

Here follow a number of names and titles, those of the three scientists mentioned above being conspicuous by their absence.

Justifying this omission, Professor Kraemer points out in his letter that

> On p. 1, I give Flueckiger's definition of pharmacognosy, and refer to my article in the footnote in which I have credited both Flueckiger and Tschirch with the great work that they have done. In this article I say:
>
> Just now Tschirch's monumental work, "Handbuch der Pharmakognosie," is about being completed and excels anything that has heretofore been published not only in pharmacognosy, but in any department of pharmacy. This work, when it is completed with the other agencies which have been at work, will do much to establish pharmacognosy as a direct[1] science and direct attention of scientists generally to its particular rôle.

The above quotation, however, is not to be found in the book, but is taken from a pharmaceutical journal to which reference is made in the footnote referred to, viz.:

> Henry Kraemer, "The Rise and Development of Pharmacognosy," *Pharm. Era*, Oct., Nov. and Dec., 1912. In this article there occurs citation of the important literature of the subject.

No doubt, as reviewer I should have traced this footnote attached to the definition of the word pharmacognosy and have plodded through three numbers of the *Pharmaceutical Era* in order to ascertain that Professor Kraemer had some time and somewhere expressed his appreciation of both Flueckiger and Tschirch. But whether Professor Kraemer appreciated the

[1] Presumably should read an exact science.

work of these masters or not was not at all the question. The fact remains that in the preface in which Vogl, Collin and others are referred to as the "great masters" and their treatises referred to as sources used in the compilation of Professor Kraemer's new book, the names of Flueckiger and Hanbury and that of Tschirch are conspicuous by their absence. That Professor Kraemer might have had a particular motive in omitting these names I had no thought of suggesting. That I merely referred to their absence as a "curious omission" ought to free me from the suspicion of any intended unkindness. As reviewer I could scarcely have said less. That later in the text two special references occur to Tschirch's "Handbuch" and that other references can be found to journal articles by Tschirch and his students does not alter in any way the failure to give credit to Flueckiger and Hanbury and to Tschirch as general sources of information, among which even the English translation by the writer of Gildemeister and Hoffmann's treatise "The Volatile Oils," and other special treatises are enumerated.

The writer had no intention to intimate that Professor Kraemer was ignorant of the master pharmacognocists referred to, for such intimation would appear ridiculous to all who know how well posted Professor Kraemer is. Neither was it the writer's intention to intimate that the omission was intentional, for all who know Professor Kraemer also know that he could impossibly be guilty of anything that had but a mere suspicion of dishonor. If reference was had to the omission at all it was, no doubt, because it seemed well nigh impossible even to an amateur, much less to one so well informed and careful as Professor Kraemer. That it did occur merely shows that even the best of us will make slips of omission, if not of commission, with our editorial pens.

That the writer should have offended a colleague of whom he has always thought highly he regrets very much. The real reason for sending you this communication is not that I desire to justify my statement, but that it gives me the opportunity to correct any unfavorable impression which my statement may have made upon the minds of those who have thought my review worth reading.

Professor Kraemer also objects to my relation in paragraphs two and three and adds

> I am at a loss to know to what you refer as apparently you have not understood my position from the beginning.

Under the circumstances I greatly regret that I ventured to write the review as requested. One thing I am certain of, namely this, that I had no intention to hurt Professor Kraemer's feelings any more than to misrepresent him. If I were not absolutely positive of this I should more than willingly apologize to my Philadelphia colleague.

Trusting that for Professor Kraemer's sake you will kindly supplement my review with this letter.

Edward Kremers

FROGS CATCHING BUTTERFLIES

I have seen common green bullfrogs, *Rana catesbiana*, catch and eat butterflies—the large, yellow and black, swallow-tailed *Papilio turnus*.

On our summer place in southern New Hampshire there was a brook where the horses were watered. In this pool there were many bullfrogs, and they were not very wild. Passing the watering place one bright, hot day in August, I saw a bevy of perhaps a dozen butterflies fluttering low over the bare, moist ground near the stream. They flew in an aimless and weak fashion not characteristic of this species, and occasionally settled upon the ground, about three feet from the water's edge.

Out of the water crept four big green bullfrogs. They went after the butterflies in the stealthy manner of a cat stalking a mouse. They did not hop or jump, but walked, or crawled, on all fours, flat on the ground—sometimes advancing rapidly, sometimes stopping short with one leg stretched out far behind. Their bodies were strained and quivering, and their interest in the pursuit did not lag for an instant.

When a frog was within a foot of a butterfly it jumped upon it and caught it in its mouth. They ate the butterflies very quickly,

swallowing them whole. I did not see a frog lose one, and I saw one frog catch and eat five. The butterflies seemed to make no effort to get away from them. Occasionally one would alight upon a frog's back. In about half an hour all but one of the butterflies had been caught. The frogs did not try to catch that one. It flew away, and soon three of the frogs went back into the water. The fourth one was apparently too "stuffed" to move.

For many days after this occurrence I watched the watering place, hoping that I might be able to get a photograph of the frogs and butterflies, but I did not see them together again.

I have consulted the best authorities on frogs, and I do not find such an instance recorded.

ALICE MAVOURNEEN MALLONEE
STRATTON, ME.

THE ALLEGED INSTINCTIVE FEAR OF SNAKES

TO THE EDITOR OF SCIENCE: Mr. T. B. Dabney's interesting letter on the "Serpent Instinct in Man," appearing in your issue of the seventh, proposes an argument substantially as follows: The fear of serpents in man is practically universal; therefore it must be instinctive. If instinctive, it must survive from a period when the serpent was a menace to the perpetuation of the human race. But such a period can only have existed before man had clothing. Therefore, it existed before his evolution from the brute was complete. But the principal locality in which man, at such a stage of his history, would have had cause to fear extinction by serpents, is India. Therefore India is probably the cradle of the human race.

To what extent the successive conclusions are supported by their premises it is not my present purpose to discuss. I have but one point to make, and that is that the fear of serpents is probably not instinctive at all. I believe it to be the result of erroneous education in childhood, perhaps accentuated by a certain timidity with regard to wild animals in general, resulting from the protected habits of civilized life.

That the fear of snakes is very general is a fact painfully present to many who, like myself, are studying herpetology with a view to protecting our useful snakes from extermination, and our country from the incalculable losses to agriculture which would thence ensue. The desire to justify the aforesaid fear is mainly responsible for the persistence of a mass of absurd superstitions about even the commonest species of snakes. But the prevalence of this attitude is not, in my judgment, sufficient reason for attributing it to an instinct of self-preservation which was the property of a supposititious brute ancestor of man, and has consequently defied the efforts of education to dislodge it, at least when there is question of first impulses. As a matter of fact, there is an equally general aversion to toads, lizards, spiders, worms and other animals possessing unpleasant qualities. The sudden presentation of such objects produces even the "panic of horror" alluded to, in quite as many instances as the sight of the serpent. And yet, none of the other creatures mentioned can at any time have menaced the existence of the human race.

If Mr. Dabney's arguments were quite conclusive, he would be well warranted in selecting India as the birthplace of herpetophobia. He is quite correct as to the mortality annually due to serpents in that country. Its immediate cause is well known to every one acquainted with conditions there. The natives of India are frequently bitten by venomous snakes because, despite all the efforts of their European masters, they insist upon going barefoot, even when otherwise well clad. If it was the adoption of clothing which first made our primitive ancestor realize that he had an even chance in the struggle for existence, one would surely expect the essential constituent of costume in India to be a pair of boots, whatever else might be wanting.

But there is positive evidence against the theory that the dread of snakes is instinctive. First, there is the common tendency of young children to play with a bright-colored snake, as they would with any toy. An innate horror of snakes as an attribute of the human species is quite inconsistent with such a fact as this.

It is frequently observed; but its first occurrence in any individual case is usually its last. For if the child's mother or nurse be at hand, there ensues a scream of terror, a mad rush to a safe distance, and a frantic admonition, perhaps even a punishment, all of which is quite enough to make a reptile thenceforth an object of fear to the child. This is where the mischief is done. The fear thus early instilled prevents investigation; lack of investigation protects ignorance; ignorance in turn corroborates the initial fear, and thus the destruction of every serpent, large or small, becomes almost a part of the average person's moral code.

In the second place, there are not a few persons who have never in their lives experienced the aforesaid horror of snakes. I am not appealing to cases where fear has been overcome by education, but to those in which the confidence born of natural curiosity has never been destroyed by positive fear instilled in early life. I have known several persons of this class, three of whom, by the way, were women, and thoroughly normal women at that. One of these last is worthy of mention in connection with her brother. This gentleman, with whom I am intimately acquainted, remembers his first sight of a snake, when, at the age of six, he and his nurse almost trod upon a small water snake in a meadow. He still recalls how utterly puzzled he was at the terror with which his nurse hurried him away from the spot, and how entirely free he was from sharing her sentiments. A little later, in early boyhood, he developed an interest in snakes which led him to hunt them in the woods and bring them home in order to watch their actions. His sister, who was even younger than he, accompanied him and sometimes helped him in this pursuit. Their father, a physician, knowing that no venomous snakes could be found in the neighborhood, not only did nothing to dissuade the children from handling snakes, but gave them little points of information and other assistance in this amusement, which they had begun without any suggestion from him. The boy, now a grown man, and a collector of some experience, has acquired an intelligent caution in capturing large snakes, owing to several experiences with their teeth; but he has never in his life felt the slightest approach to an impulse to shrink from even the largest serpent as an object of horror and aversion.

I am persuaded that any one who cares to inquire into this subject will find other cases of a similar nature, and in sufficient number to acquit his fellow-mortals of anything like a brute instinct to shrink from the serpent kind.

W. H. McClellan, S.J.

Woodstock, Maryland

Under the above caption, in Science for January 7, at pages 25 and 26, an argument for India as the cradle of the white race is based upon what the author calls the "instinctive horror of serpents." The evidence concerning such an instinct is altogether too unsatisfactory for one to assume that the horror is instinctive and it is by no means confined to the white race or universal within the white race. In addition, who knows that poisonous serpents were as abundant in India in the infancy of the white race as they are now? To what extent is their present abundance the result of the Buddhist inhibition against their destruction? Surely this inhibition must have had a very considerable influence, and just as surely it does not date back to the birth of the white race. Until it can be shown that the horror of serpents is instinctive and that poisonous reptiles were as abundant in India ages ago as they are now, the argument for the Indian origin of the race, based upon such a supposed instinct, can receive scant consideration.

Indians in northern New Mexico have been known to flee from archeological excavations because of the presence of a small, harmless lizard, which they consider deadly, and to refuse to return until the lizard had been caught and bottled. There is not the least evidence that this indicates an instinct arising from ancestral residence in a region inhabited by poisonous lizards. Poisonous lizards are at present too restricted in range and not abundant enough anywhere to constitute a menace,

and we have no evidence that they were ever more abundant or widely distributed. No one believes that the Indians originated in the region now inhabited by the poisonous lizards.

One who has seen young children playing with snakes, even with rattlesnakes, may well be skeptical about an instinctive horror of serpents. Mothers in some regions have found it advisable to deliberately teach their children to fear snakes, in order to prevent them from handling the dangerous species. In other cases the fear probably comes from association with those who had acquired the serpent horror. On the other hand there are many boys and men, and some women, who seem to be quite devoid of any such horror. The argument that one unexpectedly brought into close proximity to any kind of a snake "is suddenly seized with a panic of horror and fear," has very little weight, because it is not universally so and the same is usually the case when one is brought suddenly into close proximity with almost any kind of an animal. Does woman's proverbial fear of a mouse indicate an instinct engendered by ancestral residence in a region where such small animals were dangerous? Many beginners in biology exhibit as much horror of a worm or a caterpillar, in proportion to its size, as of a serpent.

The "instinctive horror of serpents" does not appear to be established by satisfactory evidence.

JUNIUS HENDERSON

TO THE EDITOR OF SCIENCE: Mr. Dabney's very interesting letter in SCIENCE for January 7, 1916, leads me to inquire: if the fear of snakes, by man, is an indication that there were many snakes surrounding him in primitive days, what does the fear of Indians by the American mule indicate? Was the mule developed in a region where he was surrounded by wicked Indians who abused him?

Frémont mentions this abnormal fear of Indians on the part of our ordinary mules and it has been noted by others, including myself. Frémont says:

> A mule is a good sentinel, and when he quits eating and stands with his ears stuck straight out taking notice it is best to see what is the matter.

For my part I noticed that our mules were as good as or better than most watch-dogs in giving warning of the near presence of Indians. Often before Indians were either seen or heard by any of our party the mules would snort with terror, halt, shy about, and "point" in the direction of the Indian with ears sharply bent forward and a general activity that might land a poor rider on his head. Now, why was the mule so much more afraid of Indians than horses were? I do not remember any of our horses being in the least frightened. Perhaps it was the smell of the Indian the mule detected, for their scent is very keen, but if it was the scent, why did the scent disturb them?

When we had Indians travelling with us, as was frequently the case, the mules became accustomed to their presence and were apparently unmindful of them, yet when an Indian was assigned to ride a mule there was a circus at once and it took half the camp to get him on. Once on, however, the mule being always a mighty wise being, ceased his antics and was calm as a kitten till the Indian got off and tried to remount, when we had the circus all over again. No human being can fathom the wisdom of the mule, of that I am positive, but possibly some reader of SCIENCE may be able to explain the mule's fear of Indians by some other hypothesis than that the Indian was cruel to him in the mule's original, primitive, habitat. Finally, if the fear of snakes designates the location of our primitive home where was the primitive home of the mule reasoning from his fear of Indians?

F. S. DELLENBAUGH

NEW YORK

SCIENTIFIC BOOKS

Robert of Chester's Latin Translation of the Algebra of Al-Khowarizmi, with an Introduction, Critical Notes, and an English Version. By LOUIS CHARLES KARPINSKI, University of Michigan Studies, Humanistic Series, Vol. XI. New York, The Macmillan Company, 1915. Pp. viii + 164. Price $2. In mathematics, as in art, letters, religion,

and the other domains of human activity, there are a few great classics which stand out as monuments to the world's progress. Such are the "Elements" of Euclid, the work of Apollonius on conics, the "Arithmetic" of Diophantus, "La Géométrie" of Descartes, and others of their kind, works upon which rest the great structure of modern mathematics. Among these classics stands and must always stand the first work which bore the name of algebra, the *algebr w'al muquabala* of Al-Khowarizmi, a scholar working at the court of the caliphs at Bagdad although bearing the name of his native state, Kharezm, the country about the modern Khiva. This treatise was written about the year 825 of our era, and although the world had an algebra of one kind or another for many centuries before the era of the "Arabian Nights Tales," it was Al-Khowarizmi who first set forth the science in a treatise bearing the name with which we are familiar.

Like so many Arab productions, the works of Al-Khorwarizmi attracted the attention of scholars in that remarkable period of the awakening of Europe from a long intellectual slumber, the twelfth century. First there was his arithmetic, which was translated by John of Seville as the "Liber algorismi" (Book of Al-Khowarizmi), a title from which we have such words as *algorism* (algorithm) and *augrim*. This work did much to make the Hindu-Arabic numerals known in Europe, and to it is due the name given to the algorists (*algoristi*), those who computed by these numerals instead of using the medieval counters. In the nature of things, the algebra was a less popular work, although it was more or less familiar to scholars from and after the middle of the twelfth century. Of the translators who assisted in making known the science of the Arabs to the scholars of the West, Gherardo of Cremona and Robertus Cestrensis (Robert of Chester) are among the best known, and each appears to have translated the algebra of Al-Khowarizmi. There seems also to have been another translator of this work, not to speak of Leonardo Fibonacci who has a chapter upon "Aljebra et almuchabala" in his "Liber abaci" (1202). This translator was William of Luna, and it is possible, as Professor Karpinski points out, that it is his version which was found by this reviewer some years ago in a manuscript in the library of George A. Plimpton, Esq., of New York.

Of these translations one had appeared in print before Professor Karpinski undertook his work. This is the translation attributed to Gherardo of Cremona, published about eighty years ago in the appendix to Libri's "Histoire des sciences mathématiques." Robert of Chester's translation, which has now been made available for us, had been described by Wappler from two codices (Dresden and Vienna), but only these two copies had come to light until the present writer happened upon a third one about a dozen years ago and purchased it for the Columbia University Library. This last-mentioned codex turned out to be in the handwriting of Johann Scheybl, a Tübingen professor who lived in the first three quarters of the sixteenth century. It is this manuscript which Professor Karpinski has translated and annotated with rare pains and with a scholarship which is very gratifying to American workers in this field.

The arrangement of the material is very convenient. The original work, transcribed with care, appears upon the left-hand page while a translation faces it from the opposite page, thus making it possible to compare the two with a minimum of trouble. At the foot of each page of text are notes relating to such matters as the variants in the three codices, while at the foot of each page of translation are notes explanatory of the text. We have nowhere a translation of a mathematical work in any language that is so conveniently arranged.

The task which Professor Karpinski set for himself was not an easy one. Scheybl wrote a hand which looks legible at first sight but which is difficult to read, as witness the facsimile inserted in this edition. Indeed it was no doubt due to the very fact that the handwriting was so illegible that we owe its acquisition by Columbia, since otherwise its value would have been recognized many years

ago. To be sure there was the Libri transcription of the translation attributed to Gherardo to help in reading the manuscript, and there was Rosen's translation from the Arabic (1831), but neither of these has the same wording, and neither could render much assistance in the difficult task.

The translation can best be described by the word sensible. It is fortunately not literal, for a literal translation of, say, "substantiæ radices cœquant" or "De substantia et drachmis res cœquantibus" would be unintelligible. Even such an expression as "et etiam si dicas" is better rendered by "another example" than by a verbatim translation. To be sure this freedom leads to inconsistencies, as when "Tria igitur huius substantiæ sunt radix; et substantia nouem" appears as "Therefore three (spelled) is the root of this x^2 (symbol), and x^2 is 9 (symbol)"; while the sentence "Substantia et 21 drachmæ 10 rebus æquiparantur," which follows, appears as "A square (word) and 21 units are equal to ten (spelled) unknowns" instead of, say, "$x^2 + 21 = 10x$." These variations in style are not at all confusing, however, because the student always has the original on the facing page.

The style of the problems of Al-Khowarizmi shows the Greek influence, that is, the questions are generally abstract; for example, "From a square I subtract three of its roots and multiply the remainder by itself; the sum total of this multiplication equals the square"; or, in the shorthand of modern algebra, $(x^2 - 3x)^2 = x^2$. There are, however, a few questions in the rule of three, apparently a product of the Orient, but all are so simple as to deserve no place in algebra.

Al-Khowarizmi can not be said to have made any discovery in algebra. He was essentially a compiler of problems which he solved by methods already known. He invented no symbolism as Diophantus apparently did, nor did he show the remarkable genius of this last great representative of the dying mathematics of a dying Greek civilization. He contributed nothing to the solution of the quadratic that the Alexandrian school had not known, and even the special cases of the cubic equation were as a sealed book to him. His problems lack the delicious imagery to be found in the Hindu schools of his time, and the same is true, oddly enough, of those of the great Persian algebraist and poet Omar Khayyam.

Whatever may be said, however, of the details of the work itself, it is evident that Al-Khowarizmi will always occupy a prominent place in the history of mathematics, and that Dr. Karpinski's publication will rank as the first noteworthy effort in our country in the editing of a renaissance manuscript on the subject of algebra. The thanks of all scholars are due to him for his careful work and to the University of Michigan for publishing the result in such a satisfactory style.

DAVID EUGENE SMITH

Fungoid Diseases. An English-American Book. London, Longmans, Green and Co. 118 pp. Price 65c.

The latest book on fungi to come to hand is a pleasing little volume by Thomas Milburn and E. A. Bessey, entitled "Fungoid Diseases of Farm and Garden Crops." The title betrays its English origin, for if written in America it would have been called "Fungous Diseases" or perhaps by a select few "Fun*gus* Diseases." The English have not the reputation of being so far advanced as Americans in the application of remedies for fungous diseases, yet when it comes to writing general semi-popular books on the nature of fungi they lead them by many volumes, as represented by those published by Berkeley, Smith, Cooke and Massee.

The volume under consideration, more than any of its English predecessors, puts stress on practical treatment. As partially indicated by the title, it does not discuss the diseases of fruits, but rather those of cereals, legumes, root crops and certain vegetables, with a short chapter on fungoid diseases of animals. This limits its usefulness for a wide class of readers, especially in this country. The descriptions are popular, followed in each case by a paragraph on preventive measures. The book was written "primarily for the use of farmers,

gardeners and agricultural students," and no doubt fills a need for a brief popular presentation. However, the diseases selected are on the whole a little more applicable to English than to American needs, though many of them are among our common troubles.

Milburn is secretary of agriculture and lecturer in agriculture, Lancashire County Council, England, and Bessey is professor of botany in our own Michigan Agricultural College. The latter's connection with the work has been largely confined to a prefatory note and a little of the subject-matter, especially in the introductory chapter dealing with the nature and classification of fungi and with fungicides. Bessey's connection with this book makes it the fifth on plant diseases that has been put forth by American authors in recent years, and we understand that a revision of one of these and a new one are now in preparation, showing the growing importance of vegetable pathology in this country. All of the books presented so far or under consideration are by men who have devoted more of their time to teaching than to the experimental side of plant pathology, especially as regards prevention of disease. The next author of a book on plant diseases should come from the latter class.

G. P. Clinton

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The second number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *Personal Equation and Steadiness of Judgment in the Estimation of the Number of Objects in Moderately Large Samples:* J. Arthur Harris, Station for Experimental Evolution, Cold Spring Harbor, N. Y.

While there is no certain differentiation among the experimenters in personal equation, they differ distinctly in steadiness of judgment. The latter is conspicuous in contrast with the former in that it is unmistakably influenced by previous experience.

2. *Polypeptide-Hydantoins:* Treat B. Johnson, Sheffield Scientific School, Yale University.

The formulas for a large number of polypeptide-hydantoins are set up. Some of these substances have already been synthesized and methods for synthesizing others are being developed.

3. *Recent Explorations in the Cactus Deserts of South America:* J. N. Rose, Division of Plants, U. S. National Museum, Washington.

Large collections of cacti in South America have been made, including many species which have never before been collected and some which, though collected, have been poorly described or wrongly classified.

4. *On the Albedo of the Planets and Their Satellites:* Henry Norris Russell.

A table is given of the values finally derived for the albedo of the various planets and satellites. The values are in agreement with the current views of the constitution of the bodies. The value for the earth is intermediate between those of cloudy and cloudless planets.

5. *Quantum Relations in Photo-Electric Phenomena:* R. A. Millikan, Ryerson Physical Laboratory, University of Chicago.

So far as experiment has thus far gone Einstein's equation seems to be an exact statement of the energies of emission of corpuscles under the influence of light waves. Thus the correctness of the quantum theory and the reality of Planck's h are corroborated.

6. *The Chemical Activity of the Ions of Hydrochloric Acid Determined by Electromotive Force Measurements:* James H. Ellis, Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology.

In this paper are presented accurate measurements of the electromotive force at 18, 25 and 35° of voltaic cells of the type H_2, HCl, $Hg_2Cl_2 + Hg$, with the acid-concentration varying from 0.03–4.5 normal. From the data are calculated the energy effects attending the reaction which takes place in such cells and those attending the transfer of hydrochloric acid in aqueous solution from one concentration to another. From these results are then calculated the chemical activities (or effective

concentrations) of the ions of the acid. These activities are shown to decrease with increasing concentration much more rapidly than do the ion-concentrations derived in the usual way from the electrical conductance ratio.

7. *Effects of Centrifugal Force on the Polarity of the Eggs of Crepidula:* EDWIN G. CONKLIN, Department of Biology, Princeton University.

It is difficult, but not absolutely impossible, to change the polarity of eggs and cleavage cells, and the persistence of polarity and the restoration of dislocated parts to normal condition is connected with a somewhat resistant framework of protoplasmic strands.

8. *The Emission Quanta of Characteristic X-Rays:* DAVID L. WEBSTER, Jefferson Physical Laboratory, Harvard University.

To excite any characteristic radiation it is necessary to use a potential above a critical value. The lines all increase in the same ratio for any given increase of potential. There is reason to believe that the characteristic rays are always a result of excitation of higher frequency oscillators.

9. *The Results of Investigations of the Ecology of the Floridian and Bahaman Shoal-Water Corals:* THOMAS WAYLAND VAUGHAN, U. S. Geological Survey, Washington, D. C.

The ability of corals to remove sediment from their surfaces, their mechanism for catching food, their carnivorous nature, their relation to light and temperature, and so on, have been studied.

10. *Cambrian Trilobites:* CHARLES D. WALCOTT, Smithsonian Institution, Washington, D. C.

Data have been assembled to aid in clearing up some of the problems of formations of the Appalachian region by a careful comparison of portions of their contained faunas with those of other localities.

11. *The Minute Structure of the Solar Atmosphere:* GEORGE E. HALE and FERDINAND ELLERMAN, Mt. Wilson Solar Observatory, Carnegie Institution of Washington.

The minute structure of the quiescent solar atmosphere resembles that of the photosphere. The results apparently support the hypothesis that the solar atmosphere consists of parallel columns of ascending and expanding gases, but such questions as the dimensions of the columns and the direction of motion and velocity are reserved for subsequent discussion.

12. *Monochromatic Photography of Jupiter and Saturn:* R. W. WOOD, Department of Physics, Johns Hopkins University.

The variation of the appearance of Saturn and Jupiter when photographed with light of different wave-lengths suggests a mist or dust in the planet's atmosphere which scatters the shorter wave-lengths.

EDWIN BIDWELL WILSON
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SPECIAL ARTICLES

PHOTOGRAPHS SHOWING THE RELATIVE DEFLECTION OF THE POSITIVE AND OF THE NEGATIVE IONS AS COMPARED WITH THAT OF THE ELECTRON

POSITIVELY and negatively charged ions, atomic in size (commonly called "retrograde rays"), *accompany* the stream of electrons issuing from the cathode in a highly exhausted discharge tube. Thomson[1] studied their properties by placing a photographic plate within the tube in such a position as to receive these rays after being deflected simultaneously by an electric and a magnetic field. When the fields are coincident (not crossed) the displacements on the photographic plate are in directions at right angles to each other. The photographic method is now in common use.

To the writer's knowledge no photographs, however, have been published in which all three of the component carriers—the positive ion, the negative ion and the electron—are shown simultaneously on the same plate. Since the mass of the electron is only 1/1700 that of the hydrogen atom, and since the square of the magnetic deflection varies inversely as the mass, it follows that the electron is driven off the plate by a magnetic field that would give the ion only an appreciably small deflection. By weakening the magnetic field the trace due to the electrons may be retained on the plate.

Two full-sized photographs, Figs. 1 and 2,

[1] J. J. Thomson, "Rays of Positive Electricity," pp. 75, 1913.

with key, Fig. 3, are submitted. Comparatively weak magnetic fields were employed.[2] The two coincident deflecting fields are sketched in Fig. 3, in which the direction of

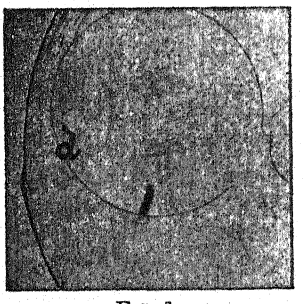

Fig. 1.

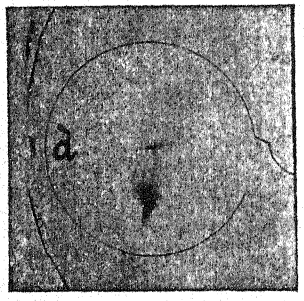

Fig. 2.

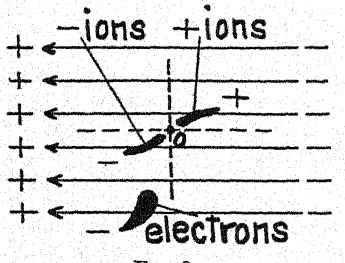

Fig. 3.

the electrostatic field is indicated by the minus and plus signs, while the arrow heads show the direction of the magnetic field. Again, magnetic deflections are up or down, while electrostatic deflections are to the right or left. The undeflected spot 0 is due to carriers that have lost their charge before entering the deflecting fields. In these photographs, Figs. 1 and 2, the traces due to the positive and negative ions unite at the central undeflected spot, the portion to the right of 0 being due to positive ions and that to the left negative ions, while the trace *e, due to electrons*, is distinctly separated from 0 and at some distance from it, and as we should expect, is in the same quadrant as the heavier negative ions. In Fig. 1 the time of exposure was 10 minutes, electrostatic field 2,070 volts per centimeter, magnetic field 1.7 amperes, and the vacuum .011 mm. mercury; while in Fig. 2 the corresponding values were 20 min., 2,070 volts, 2.25 amperes, and .005 mm. mercury. The effect of the stronger magnetic field is distinctly shown in Fig. 2 by the increased displacement from 0 of the trace due to the electrons.

[2] For arrangement of apparatus see C. T. Knipp, *Phys. Rev.*, Vol. XXXIV., March, 1912.

Chas. T. Knipp

Laboratory of Physics,
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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

The sixty-eighth meeting of Section E, Geology and Geography, of the American Association for the Advancement of Science, was held in Orton Hall, Ohio State University, Columbus, Ohio, December 28 and 29, 1915. Vice-president C. S. Prosser presided. Professor R. D. Salisbury, University of Chicago, was elected vice-president of the association, and chairman of Section E for the next meeting, to be held in New York. Dr. C. P. Berkey, Columbia University, was elected a member of the council, Dr. J. W. Beede, University of Indiana, a member of the sectional committee, and Dr. E. R. Cumings, University of Indiana, a member of the general committee.

The titles and abstracts of papers presented before Section E are given below:

The Classification of the Niagaran Formations of Western Ohio: Charles S. Prosser.

A series of sections along Ludlow Creek, near Covington and near Lewisburg in western Ohio, which extend from the upper part of the Richmond formation to near the top of the Niagaran series are fully described. Also the Derbyshire Falls section, near Laurel, Indiana, is described and it is shown that this important and well-known limestone extends into Ohio and is worked at several

quarries, as for example, the Lewisburg Stone Company, northwest of Lewisburg and the Jackson quarry, south of Covington. Dr. Foerste's name of Brassfield formation is adopted for what was formerly called the Clinton limestone in Ohio, and as the result of recent work by Schuchert and others it is to be correlated with the Medina rather than the Clinton formation of New York. If this correlation be accepted, then the Brassfield formation is to be transferred from the Niagaran to the Oswegan series of the Silurian system.

The following classification is proposed for these formations in western Ohio:

Cayugan series.—Monroe Formation.

Silurian System:

- Niagaran Series:
  - Cedarville dolomite. Lower 15 feet shown.
  - Springfield dolomite, 13 feet.
  - A mottled-colored zone which has been called West Union, 4 to 7 feet.
  - Laurel Limestone, 7 to 10 feet.
  - Osgood Beds:
    - Shale zone, 2 to 3 feet.
    - Dayton limestone, 8 to 11 feet.
- Oswegan Series:
  - Brassfield limestone, 26½ to 28½ feet.

Cincinnatian Series. Belfast bed at top of Richmond formation.

The Stratigraphic Position of the Hillsboro Sandstone: CHARLES S. PROSSER.

In Highland County in southern Ohio a sandstone composed of grains of quartz sand occurs which was named the Hillsboro sandstone by Dr. Orton and regarded as forming the uppermost division of the Niagaran series. In the summer of 1915 outcrops were found on the southern slope of Quaker Hill, about five miles north of Hillsboro, which give a better section than any that has previously been described. The hill is capped by the Ohio shale; below this is 13 feet of drab-colored compact limestone with the lithologic characters of the Monroe formation and containing fossils that occur only in this formation. Then 2½ feet of quartz sandstone is exposed which is the Hillsboro, and stratigraphically below this sandstone is limestone lithologically like the Monroe in which fossils were found that are known only in the Greenfield dolomite, which is the basal member of the Monroe formation. Twelve and one fourth feet below the exposed base of the upper sandstone is a 2-foot layer of similar sandstone which probably has been included in the Hillsboro sandstone and beneath this is nearly 3 feet of limestone still with the lithologic appearance of the Monroe, but fossils were not found in it. Under this zone is porous rock with the lithologic character of the Cedarville dolomite in which specimens of *Trimerella* were found, a genus of brachiopod shells that is known only in the Cedarville and Guelph formations of North America and the upper part of the Silurian in the Baltic region of Europe. The occurrence of fossils known only in the Greenfield member of the Monroe formation in rock lithologically like the Monroe below the higher layer of sandstone and the continuance of the rock with the lithologic appearance of the Monroe below the lower sandstone is believed to prove that the Hillsboro sandstone belongs in the Monroe formation like the somewhat similar lithologic Sylvania sandstone of northwestern Ohio and southeastern Michigan.

The Berea Formation of Ohio and Pennsylvania: WALTER A. VERWIEBE.

The Berea has been studied in Ohio notably by Dr. Prosser, in Crawford county, Pa., by I. C. White, and along the Allegheny river by Charles Butts. In 1915 the author made an attempt to correlate the work of these three investigators. As a result the following conclusions were reached: (1) The Berea is represented in Pennsylvania by the Corry and Cussewago formations of White. (2) The Corry sandstone increases in thickness when followed eastward from the state line, attaining a thickness of about 50 feet along the Allegheny River. (3) The Corry sandstone becomes gradually coarser toward the east. (4) A limestone layer is practically always to be found under the Corry. (5) The Cussewago sandstone thins out and disappears from the section about longitude 80° 5′ W. (6) The Corry sandstone is represented along the Allegheny River by the sandstone indicated on Mr. Butts's general section as lying about 160 feet above the sandstone labeled "Berea (Corry)." (7) The Berea is absent along the Allegheny River north of Tidioute. The sandstone regarded as the Berea north of this point is probably the Venango First Oil Sand.

The Origin of the Newark Series in the Philadelphia District: HELEN MORNINGSTAR.

In the cut made by the Philadelphia and Western Electric Railway at the De Kalb Street Station, Bridgeport, Pennsylvania, the lowest member of the Newark Series in the Philadelphia District, the Stockton, is well exposed and consists of alternating beds of red and gray sandstone and conglomerate with pebbles varying from a fraction

of an inch to four or five inches in diameter. The constituents of the rock are coarse quartz sand grains, quartz pebbles, mica and a large amount of decomposed feldspar. Crossbedding is very prominent, and the conglomerate lies in lens-shaped masses which are tilted in almost any direction. A black carbonaceous layer of a few inches in thickness is also found in the outcrop. The character of the rock at this locality seems to prove conclusively that it is of terrestrial origin and accumulated as fluviatile deposits on piedmont slopes under semi-arid climatic conditions. The origin can best be explained by comparison with the large alluvial deposits forming at the present time in the Valley of California between the Sierra Nevada Mountains and the Coast Range, where a semi-arid climate prevails, where there is a constant large supply of débris for the streams to transport, and where the change of gradient is sufficient for the deposition of the load. In such cases there is an assortment of sediments, the coarser materials being deposited in the piedmont regions while the finer materials are carried farther out. As the deposit seen in the Railway Cut at the locality described is situated on the extreme southeastern border of the Newark area in the vicinity of Philadelphia, it is best explained as the work of a stream which flowed into the region from the southeast, the coarse conglomerates representing a phase of alluvial deposition such as is found near the point where the stream emerges from a bordering highland. The crossbedding, such as found here, is a marked characteristic of alluvial deposits made by streams of an arid or semi-arid climate during the period of torrential rainfall. The red color of the rocks and the large amount of decomposed feldspar, also indicate semi-arid climatic conditions. The presence of the carbonaceous layer, the total absence of marine fauna, the ripple marks, sun cracks, animal tracks and the remains of land animals, which have been found in the Newark rocks of the Philadelphia District—all point toward a terrestrial or continental origin.

The Ordovician-Silurian Boundary in Ohio: W. H. Shideler.

Comparing the proposed new division plane at the base of the Richmond with the commonly accepted division at the top of the Richmond, 14 per cent. of the 395 Maysville species lived on into the Richmond, while not one of the 494 Richmond species lived on into the Medina or Clinton. Of the Richmond genera, 42 per cent. are unknown in the Maysville, compared with the 67 per cent. of the Medina and Clinton genera unknown in the Richmond. Three families end with the Maysville, fourteen with the Richmond. Three families first appear with the Richmond, while thirty-five families, two suborders, three orders and one subclass, are introduced in the Medina and Clinton. In Ohio the Belfast beds carry a fauna of Brassfield (Ohio "Clinton") species, so the top of the Richmond is at the top of the Elkhorn beds, and this position is taken as the Ordovician-Silurian boundary.

A Geological Section of the Lime Creek Beds of Iowa: A. O. Thomas.

Brecciation Effects in the Saint Louis Limestone: Francis M. Van Tuyl.

The Saint Louis limestone is locally much brecciated and disturbed in southeastern Iowa. Two main types of breccia may be recognized: First, an original breccia which occurs both as reefs and as stratified beds in the formation, and second, a subsequent breccia produced by mashing on a large scale in late Mississippian time. Small folds and overthrust faults are associated with the breccia of the last type.

An Organic Oolite from the Ordovician: Francis M. Van Tuyl.

The siliceous oolite which constitutes the transition bed between the St. Croix sandstone and Prairie du Chien dolomite in the Upper Mississippi valley possesses in addition to the ordinary concentric and radial structure minute sinuous tubules similar to those which characterize the calcareous alga, *Girvonella*.

The Stratigraphy of Flint Ridge, Ohio: Clara G. Mark.

Flint Ridge is located about forty miles east of Columbus and a few miles west of Zanesville, Ohio. It consists of a ridge extending in a general east and west direction and conspicuously higher than the surrounding country. All along its summit may be seen blocks of flint, many of them small, but some large enough to weigh several tons. These blocks of flint appear to be the broken-down fragments of a once continuous ledge. There has been a great diversity of opinion concerning the stratigraphic position of this flint and it has been tentatively assigned to various horizons, from that of the Lower Mercer limestone, to that of the Middle Kittanning, or No. VI., coal. In the spring of 1915 Mr. John Turkopp, a graduate student of Ohio State University, in making a geologic map

of Flint Ridge, found a gully in Poverty Run near the eastern end of the ridge, which shows the most complete section of the rocks below the flint that has yet been found. This paper gives a detailed account of this section, another one at the western end of the ridge, and for the purpose of correlation, one of Putnam Hill at Zanesville. Two limestones and two flints occur in the Poverty Run section. The upper limestone, which directly underlies the higher flint, resembles the Upper Putnam Hill limestone at Zanesville; the second limestone 27 feet below the base of the upper one resembles the Putnam Hill limestone, and a black flint 22½ feet below the base of the lower limestone resembles the Upper Mercer limestone at the foot of Putnam Hill, Zanesville.

Correlation of the Conemaugh with the Kansas-Pennsylvanian: J. W. BEEDE.

The Cleveland Gas Field: J. A. BOWNOCKER.

A year or two after gas was discovered at Findlay in 1884 a deep well was sunk at Cleveland and a little gas secured but it was not of commercial proportions. Other tests were made from time to time but without success until February, 1912, when two good wells were secured in the "Clinton" sand at a depth of about 2,700 feet. A year later 150 strings of tools were at work and wells were sunk in large numbers on town lots and in this way much money wasted. The producing territory lay along the western edge of Cleveland and in the adjacent town of Lakewood. Later work has carried it some miles west of that place and southwest toward Berea. The largest well yet drilled in this field had an initial flow at the rate of 14,000,000 cubic feet per day and the closed or rock pressure of the field was about 1,050 pounds per square inch. The limits of this field have not been determined. In February, 1913, a large volume of gas was struck in the valley of the Cuyahoga, well within the city limits of Cleveland. The initial flow of the first well started at 10,000,000 cubic feet per day and other wells were sunk as rapidly as the drill could be forced down with the result that the limits of this field were soon determined while the proximity of wells made them short lived. The producing sand was not the "Clinton" but a higher one imbedded in the Silurian limestones. Rocks in the vicinity of Cleveland rise to the northwest and anticlines have not been located, though small ones may be present. Apparently the gas has worked its way from the southeast to the higher places, that is, to vicinity of Cleveland.

Oolitic Building Stone of the Bowling Green Field, Kentucky: M. H. CRUMP.

This remarkable building stone so beautifully seen in such handsome edifices as St. Thomas (Episcopal) Church, 53d street and Fifth avenue, New York; Hall of Records, Brooklyn; Manufacturer's Club, Philadelphia; the Everett mansion, Sheridan Circle, Washington, D. C.; and in many federal buildings throughout the United States, is found in the upper beds of the St. Louis limestone, covering an extent of some 200 miles in the county of Warren, state of Kentucky. It runs from ten to twenty-two feet thick, without a seam, and averages fifteen feet of commercial stone, which means 653,400 cubic feet per acre, or a total of more than eight and one third billion cubic feet immediately in sight, and ready to be put on the cars for less than ten cents per foot, where it is worth fifty cents. Professor Shaler speaks of it as "Occurring in layers of excellent form for use, readily worked, and with a rare quality of endurance—rather soft, so that it can be easily carved, but on exposure acquires much greater hardness. Add to this a rare beauty of color—a cream tint—and an endurance of color, and you have all the desirable qualities of a building stone well represented." Its ultimate crushing strength per square inch is 6,157 lbs., weight 167 lbs., carbonate of lime 97.69 per cent., water absorbed 6.2 per cent., U. S. Government Test.

Reames Cave: THOMAS M. HILLS.

Reames Cave, which is located in central Ohio, is the largest cave in the state. It occurs in zones B and C of an outlier of Columbus limestone, which was shaped by the ice and partly covered by drift. The total length of the galleries is nearly a mile. They have a maximum width of fifty feet. Deposition of iron oxide and calcium carbonate are being made contemporaneously.

Comparative Notes on the Loess of the Danube and the Rhine: B. SHIMEK.

The Loesses of the Mississippi Valley: B. SHIMEK.

A discussion of the several types of loess, with notes on their geographic distribution and stratigraphic relation. The several loesses represent distinct periods of time. Their peculiarities are, in part, accounted for by differences in source of materials.

Group Relationship among Physiographic Features as an Aid in Field Interpretation: GEORGE D. HUBBARD.

This paper shows what is meant by group relationship in physiography; how the notion of group relations among features is of value in description, explanation and classification of the features, and how a recognition of such relationships among features may be of assistance in the interpretation of field problems.

The Pleistocene of Capitol Hill, Des Moines, Ia.: James H. Lees.

Some Evidence Regarding the Duration of the Yarmouth Inter-glacial Epoch: George F. Kay.

That the time interval between the retreat of the Kansan ice and the advance of the Illinoian ice into Iowa was of long duration is suggested strongly by recent studies in the area of Kansan drift in southern Iowa. This view regarding the Yarmouth Inter-glacial epoch is supported by evidence as follows: (1) On the Kansan drift where erosion has been slight there is a thoroughly leached, non-laminated, tenacious clay called gumbo, twenty feet or more in thickness, which is thought to have been formed chiefly by chemical weathering of the upper part of the Kansan drift. (2) Diastrophic movements subsequent to the formation of the gumbo, the country having been elevated one hundred and fifty to two hundred feet. (3) A mature topography which was developed by erosion after the diastrophism and, apparently, in the main, before the close of the Yarmouth epoch.

Valley Trenching and Graduation Plains in Southern Indiana and Associated Regions: Clyde A. Malott.

This paper attempts to establish a partial peneplain in the central Mississippi valley post-Lafayette in age. East White River basin of southern Indiana furnishes the type region, where at least three former base levels are in evidence. Through the middle part of this river basin in the region of limestones and resistant sandstones, a gradation plain is evident at about eighty feet above the present streams. This gradation plain traced to the areas of soft rocks corresponds with the general upland level of the soft Devonian shale and lower member of the Knobstone group of middle eastern Indiana and of the soft sandstones and shales of the productive Coal Measures of the southwestern part of the state. At a hundred to a hundred fifty feet above this gradation plain is a peneplain of rather general prevalence in the harder rocks of the state. It is represented in the soft rock areas by monadnocks and rugged uplands only. This peneplain is called the Mitchell plain in southern Indiana. Again in the harder rocks is found a yet higher base-level, a hundred to two hundred feet above the Mitchell plain. This level is represented by monadnocks and flat-topped divides. It forms the highest land in the southern part of the state. The age of the gradation plain, marked by the lower uplands of the state, is found by tracing it across southern Illinois to the Ozark region, where it is seen to be developed at a lower level than the peneplain which has upon it the gravels of supposed Lafayette age. Moreover the Mitchell peneplain can be traced interruptedly by monadnocks to the Shawneetown Hills and Karbers Ridge which represent the level of the Lafayette gravel peneplain of the Ozark Plateau. The highest level of southern Indiana is correlated with the Lexington plain of Kentucky and the Highland Rim of Tennessee, and with less assurance with the base-level some two hundred feet above the Lafayette level of the Ozark region. In literature it is placed in early Tertiary age. Evidence of a post-Lafayette gradation plain or local peneplain is found in several places in the Mississippi valley. In the Nashville Basin of Tennessee the flat peneplain along Stones River is some eighty to a hundred feet below the frequent Lafayette gravel capped hills, and the stream is also trenched below the peneplain. Again, in the Driftless area of Wisconsin, broad "basin valleys" are found at one hundred feet lower than the Lancaster peneplain determined by Grant, Bain and others to be Lafayette in age. These "basin valleys" no doubt represent a gradation plain, and are in a position similar to the gradation plain of Indiana. Still another instance may be found in the Parker strata of the upper Ohio. Thus, taking all the evidence into consideration, it seems that there is a rather widespread base-level plain of post-Lafayette age over the Mississippi valley. In southern Indiana it was developed long before the advent of the Illinoian glacial ice.

The Extremes of Mountain Glacial Erosion: Wm. H. Hobbs.

In a series of articles printed in the year 1910, the writer pointed out that the mountain districts which in the past have been occupied by mountain glaciers, represent each a particular stage in a cycle of erosion, or especially of a receding hemicycle. The Bighorn range of Wyoming was cited as the best example of the early stage where glacial sculpture has modified but a small portion of the inherited upland surface. This topographic

type was designated a *grooved upland*, since the glacial troughs heading in semicircular cirques invade the upland. The opposite extreme, in which the entire inherited surface has been destroyed through glacial sculpture, was termed a *fretted upland* for obvious reasons, and the Alps cited as the type example. The characteristic of this type of upland—the Sierra—consists in main lines of palisades, or comb-ridges, from which lateral spurs of palisades diverge at frequent intervals. The general dominance of this type of topography in most regions where mountain glaciers have been, would seem to imply that mountain glacial sculpture proceeds with great rapidity through the enlargement and extension of the cirque; and that, further, this process is slowed down so soon as the pre-glacial upland has been removed. Otherwise we should expect that cols, or passes carved by cirque extension, would be much lower than they are.

A more extreme case of glacial sculpture seems to be illustrated by the northern Rocky Mountains, particularly within the Glacier National Park. Here in place of the comb-ridges, so characteristic of the fretted upland, we find an abundance of monument-like peaks, not the true horns merely within the fretted upland, but lower eminences which seem to have resulted from progressive lowering of the cols and the consequent coming into prominence of the broader parts of the comb ridges at either side of the entrance to the cirque from the U valley. This type of upland, an extreme product of mountain glacial erosion, we may designate a *monumented upland*. That the Bighorn range of Wyoming and the Glacier National Park thus present the extremes of mountain glacial erosion, was confirmed by studies which were carried out upon the ground in both districts during the summer of 1915.

The Earthquake in the Imperial Valley on June 22, 1915: W. H. HOBBS.

Outliers of the Maxville Limestone in Ohio, North of the Licking River: G. F. LAMB.

A Giant Pot-hole near Scranton, Pennsylvania: H. N. EATON.

The pot-hole in question is located about seven miles northeast of Scranton, Pa., in the ravine of a small stream on the southern side of Bald Mountain, 340 feet above the Lackawanna River. It is known to local naturalists and mining men on account of its great size, having a width at the top of 34 feet and a depth from the top to the débris at the bottom of 29 feet. The original depth was probably much greater. The bed rock is a gently dipping sandstone of a lower horizon of the Coal Measures. The origin of the hole by rotary abrasion is evident from its contour as shown in the photographs. Fluted and scoured rock surfaces in the immediate vicinity afford ample evidence of violent stream work, and although the glacial history of the region is not fully known it is probable that the pot-hole was formed by a stream issuing from the melting ice.

A New Occurrence of Crystallized Willemite: R. W. CLARK.

The willemite occurs in the Star District, Beaver County, Utah, in drusy masses of small crystals, which are sometimes colorless and sometimes red due to dilute coloring matter. It is associated with hemimorphite, calcite, mimetite, quartz, cerussite and limonite. The crystals show the following forms: c(0001), e(01$\bar{1}$2), a(11$\bar{2}$0), m(10$\bar{1}$0). The indices of refraction determined under the microscope by the immersion method are $\epsilon = 1.716$, $\omega = 1.690$.

The Girdled Mountain: A Direct Consequence of General Desert Erosion: CHARLES KEYES.

For the development of those rock-floored piedmonts which so often are characteristic of many arid regions there is an explanation much simpler than that usually given—one that is more in accordance with recent advancements in our knowledge of desert erosion. It does away with all of the assumptions necessarily arising out of the adoption of the old hypothesis which postulates prodigious valley-fill, and an uncovering by mountain freshets of an ancient bed-rock surface of the shallow margins of the intermont spaces. This old hypothesis had its foundation in the impression that the intermont plains are aggraded tracts instead of surfaces now undergoing rapid degradation, and that the agency is stream-corrasion much the same as in humid climates except perhaps somewhat less vigorous. The phenomenon is now believed to be one of the minor expressions of eolic erosion on that part of the orographic block which suffers maximum abrasion through natural sand-blast action. Many lofty desert mountains are thus deeply girdled just above the level at which the general plains surface meets them.

The Origin of the Coarse Breccia in the St. Louis Limestone: WILLIAM C. MORSE.

At least two kinds of breccia are present in the St. Louis limestone, one fine and the other coarse. The fine breccia is, in many cases, confined to a layer, or to two or three layers, at one or different

horizons, and undoubtedly owes its origin to forces operative at the time of deposition. The coarse breccia, on the other hand, is developed without regard to the limits of the layer and has a patchy, horizontal distribution. In one of the quarries in St. Louis County, Missouri, layers superjacent to a mass of coarsely brecciated limestone are bent down in such a way as to reveal the former presence of a limestone cavern. This structure in connection with other features led to the conclusion that the breccia is due to the collapse of the partially dissolved layers and of the cavern roof, and that the coarse breccia in western Illinois may have originated in a like manner.

Combination of Structures in the Colmar Oil Field in Western Illinois: William C. Morse.

In the Colmar Oil Field in western Illinois the Hoing sand is productive at 80 to 100 feet above sea level in the Lamoine terrace and at 165 feet in the adjacent Colmar dome. Salt water backs up the oil to the very edge of the terrace and, in fact, fills the lower part of the sand in the terrace itself. It likewise backs up the oil to the very crest of the dome. In some of the non-productive walls the sand is not present. From these facts it is evident that the sand in the terrace and in the dome constitutes two entirely separate patches; and recent development proves that the distribution of the oil and the salt water is dependent upon the structure of each individual patch of sand. In other words, the distribution of the oil and the salt water is not the result of the larger structure alone, but particularly that part of the larger structure within the limits of each sand patch. For example, the distribution of the oil in this area of elevated rocks is confined to the highest part of one patch of sand (terrace) and to the highest part of the other patch (dome).

Some Structural Geology of the Piedmont: John E. Smith.

The rocks under discussion are located in the "Slate and Schist Belt" in the eastern part of the Piedmont in North Carolina. A deep layer of mantle rock permits but few outcrops where unweathered material may be obtained for study. The sedimentary rocks consist of conglomerates, "slates," and breccias, each of which in places has been silicified. The gneisses and schists are derived from igneous and sedimentary rocks. These "Ancient Crystallines" are intensely folded, have steep dip with axes extending northeast and southwest in Orange County, are much reduced by erosion, and in many places have been cut by igneous intrusions and extrusions. The igneous rocks consist of granites, syenites and diorites, occurring as stocks some of which show zonation, and felsites, chiefly rhyolites, many of which have been sheared and altered. The rhyolites nearly all exhibit flow structure and appear prominently as rounded monadnocks and short ranges of low hills. The dikes are chiefly basic rocks. Contacts are rarely exposed. (Illustrated with structure sections.)

Geographic Causes in North Carolina: John E. Smith.

The natural divisions of North Carolina are the mountain region, the Piedmont plateau and the coastal plain. The climate varies with the elevation and with the distance from the sea, reaching its maximum range of temperature in the western part and the minimum along the coast. The rainfall is greatest in the southern part of the mountain region and near the sea. Some of the lake and swamp depressions of the coastal plain were formed by unequal deposition near the shore of a former sea and some by low barrier ridges built before the sea withdrew. The water in some of the lakes is partly of artesian origin. The railway systems are in topographic adjustment and there are two great power systems, one in the Piedmont and one on the coastal plain. The value of land is controlled by topography, fertility and accessibility, that of least value being the most remote in the mountains, the most rugged in the Piedmont, and the most swampy on the plain. Mills and factories are located chiefly in the Piedmont because those first built used water power. Hydro-electric is most popular now. Many of these industries came to the south to reduce expenses by operating in a mild winter climate near the raw materials used with cheap labor. The people of the state are distributed in accordance with the above-mentioned influences. (Illustrated with maps and charts.)

George F. Kay,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 547th regular, and 36th annual meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, December 18, 1915, called to order by President Bartsch, at 8 P.M., with 27 persons present.

On recommendation of the council the following persons were elected to active membership: H. R.

Rosen, U. S. National Museum; Miss Virginia Boone, U. S. National Museum; Ira N. Gabrielson, Biological Survey; James Silver.

Annual reports of officers and committees were submitted.

Election of officers for the year 1916 resulted as follows:

President, W. P. Hay.

Vice-presidents, J. N. Rose, A. D. Hopkins, Hugh M. Smith and Vernon Bailey.

Recording Secretary, M. W. Lyon, Jr.

Corresponding Secretary, W. L. McAtee.

Treasurer, W. W. Cooke.

Councillors, N. Hollister, J. W. Gidley, William Palmer, Alex. Wetmore, E. A. Mearns.

President Hay was elected a vice-president of the Washington Academy of Sciences.

The president announced the following committees:

Committee on Publications, N. Hollister, W. L. McAtee, W. W. Cooke.

Committee on Communications, Wm. Palmer, Alex. Wetmore, Lewis Radcliffe, J. W. Gidley, W. R. Maxon, H. S. Barber.

THE 548th meeting of the society was held in the Assembly Hall of the Cosmos Club on Saturday, January 15, 1916, called to order by President Hay at 8 P.M. with 40 persons present.

The president noted the recent death of F. M. Webster, long a member of the society.

Upon recommendation of the council the following were elected to active membership: H. F. Taylor, Bureau of Fisheries; Douglas C. Mabbott, Biological Survey; Wallace M. Yaters, Department of Agriculture.

Under the heading of Brief Notes and Exhibition of Specimens Mr. Wm. Palmer exhibited a specimen of seahorse which actually came from near Colonial Beach, Chesapeake Bay, but which had attained much newspaper notoriety as having been caught in the Tidal Basin, D. C. He also exhibited the collector's sketch of a pipefish which had been captured in the Tidal Basin.

The regular program was a communication by W. W. Cooke, "Notes on Labrador Birds." Mr. Cooke gave an interesting account of Mr. Clarence Birdseye's experiences and travels in Labrador during the past four years while engaged in farming silver gray foxes for their furs, describing the difficulties under which he labored and the disastrous effect of the European war on the fur market. The speaker then gave an historical survey of Labrador ornithology from the early days of Cartwright to Mr. Birdseye's latest observations, which includes the extension of range of several species of birds. Mr. Cooke's communication was illustrated with lantern slide views of maps of Labrador, maps of migrations of certain birds, and views of several birds which had lately been observed for the first time in eastern Labrador. Mr. Birdseye's observation on Labrador birds will appear in full in the April *Auk*.

Mr. Cooke's communication was discussed by Mr. Wm. Palmer and by Mr. Alex. Wetmore.

THE 549th regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, January 29, 1916, called to order at 8 P.M. by President Hay, with thirty persons present.

The recent and previously unnoticed deaths of members of the society, Dr. G. D. Elliot, A. M. Groves and C. E. Slocum were noted by the president. On recommendation of the council Dr. Walter K. Fisher, Stanford University, was elected to active membership.

Under the heading Brief Notes Dr. L. O. Howard told of some of the published anecdotes regarding the entomologist General Dejean who served under Napoleon I., and of his zeal as a collector even under the excitement of battle.

Under the same heading Dr. H. M. Smith called attention to the successful introduction of the tilefish into the markets, restaurants and homes of the United States.

Under the heading Exhibition of Specimens Dr. L. O. Howard exhibited a photographic lantern slide of Orsini's statue, *Proximus Tuus*, representing a malarial stricken Italian peasant. The statue was exhibited at the San Francisco fair and illustrations of it are used in a California antimosquito campaign. By way of contrast Dr. Howard showed a group of healthy children on the formerly malaria-infested Roman Campagna.

Under the same heading Mr. William Palmer exhibited several bones of extinct cetaceans recently collected by him at Chesapeake Beach, Maryland. He called attention to the work of Cope and of other paleontologists on this group and pointed out the relationships of the forms with some of the modern cetaceans.

The regular program comprised a paper by Ned Dearborn, "Fur Farming in Alaska." Dr. Dearborn pointed out the possibilities of fur farming in Alaska, stating that at present there are 75 localities in that territory where such farming is

carried on to a greater or less extent. The possible animals that may be bred for fur are the fox, mink, marten, otter and beaver, but so far it has only proved practicable with foxes and minks. Silver foxes are successfully bred in the interior and fed on salmon and rabbits to a large extent. Blue foxes are successfully raised along the coast, especially on certain of the islands. The paper was discussed by Dr. C. W. Stiles who called attention to the prevalence of certain forms of hookworms in the dogs and foxes of Europe and Alaska but seldom found in the dogs of the United States.

M. W. Lyon, Jr.,
Recording Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The 110th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., Tuesday, February 1, 1916. Fifty-three members and four guests were present. Messrs. Chas. H. Clark, Felix J. Schneiderhan, and Dr. T. Tanaka were elected to membership. The following papers were presented:

Egyptian Use of Date Tree Products Other than Fruit (with lantern): S. C. Mason.

To be published in full elsewhere.

Botanical and Economic Notes on the Dasheen (with lantern and exhibit): R. A. Young.

The dasheens represent one type of the taro, which is well known in the Orient and the Islands of the Pacific. All belong to the genus *Colocasia*. The variety under special consideration was the one known as the "Trinidad" from the island of Trinidad. It is believed to have come originally from China. Slides were shown illustrating the differences in floral and other characters between two very distinct types of *Colocasia*, which for the past sixty years have been included under the name *C. antiquorum* (L.) Schott. One of the types, which includes the dasheen, was recognized tentatively by Schott, in 1823, as a good species, under the name *C. esculenta* (L.) Schott. In 1856 he reduced it to a varietal rank. The other type, which is represented by the "qolqas" or "colocasia" of Egypt, is the species *C. antiquorum*. It is contended that the reduction of *C. esculenta* to varietal rank was an error and it is proposed to restore it to specific rank. The true *C. antiquorum* properly includes the common elephant-ear plant, generally referred to as *Caladium esculentum*, of Ventenat.

The dasheen is gaining in importance in the far south, and a northern market is developing. Many culinary experiments have been made and a number of delicious and attractive dishes have resulted. After the program, dasheens which had been parboiled and baked with electric stoves, were served.

The Pathological Inspection Work of the Federal Horticultural Board: Geo. R. Lyman.

The Plant Quarantine Law seeks to prevent the introduction into the United States of injurious plant diseases from abroad by requiring the inspection of imported plant material. The inspection of commercial importations presents few difficulties, inasmuch as the variety of host plants involved is not great and the importations are ordinarily from countries where the diseases are well known. But importations by the Department of Agriculture for experimental and introduction purposes present many problems, since they come from every quarter of the globe and are practically unlimited in variety of host plant. Both host and disease may be new and hence potentially dangerous. All such importations are received in a specially constructed inspection house in Washington, and the packages are opened in the presence of the inspectors, all wrappings being burned. The plant material is closely examined and suspicious specimens are referred to experts of the Department of Agriculture for study and determination. Extraordinary precautions are taken to prevent infection being carried on the hands or clothing of the inspectors.

After inspection the material may be (1) passed, if it is apparently clean; (2) burned, if dangerous diseases are found; (3) ordered fumigated or cleansed when the pests found can be eradicated by such treatment (facilities for treating material are present in the inspection room); or (4) ordered grown in quarantine. The quarantine greenhouse adjoining the inspection room is divided into small units where suspicuous plants may be isolated and grown under close observation until the proper disposition of them is determined.

Moreover, much of the material which passes inspection is ordered grown in the propagation gardens of the government, one of which is situated at Yarrow, Maryland. Here the plants are propagated and grown under observation and are given a last close inspection when finally ready for distribution.

W. E. Safford,
Corresponding Secretary

SCIENCE

FRIDAY, MARCH 24, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ADVANCING PENDULUM OF BIOLOGICAL THOUGHT

THE specialist often finds it interesting, and sometimes profitable, to pause in the intensive pursuit of his own little field and take time to contemplate the general trend of thought in biological science.

In my own case it is often borne in upon me that the zoological public is little interested in the group of animals, the Hydroida, with which I work, and it is a positive relief to contemplate the broader aspects of the field of natural science.

Let this, then, be my excuse for presenting a paper that is non-technical in form and more of the nature of a general survey of the path along which we have traveled in the acquisition of general biological truth.

Upon taking such a survey it at once becomes evident that progress has been made along a sharply zigzag road, with successive swings to right and left, involving abrupt changes of accepted theories. In fact this path is that which would be traced by a pendulograph as made by an advancing pendulum. The actual movements would be mainly to the right and left of a median line representing actual progress, but each swing of the pendulum would make a slight but sure advance along that median line.

The idea is not really new and has been incidentally touched upon by various writers; but it seems to me that it would be profitable to consider with some care a few of the comparatively recent swings of the pendulum, to note the advance made by each, and possibly to arrive at some general

statements as to our attitude toward the work and our fellow workers.

For this purpose let us give our attention to some of the more important swings of our pendulum that have taken place since the appearance of that epochal event, the appearance of Darwin's "Origin of Species by Means of Natural Selection."

As is usually the case, the workers immediately following Darwin were inclined to outdo their leader, to out-Darwin Darwin and to overwork the theory which he advanced, making natural selection the sole efficient cause of the origin of species.

By far the ablest and most prominent writer who thus swung the pendulum away from the sane and reasonable path along which Darwin had advanced was August Weismann, who startled the world with his declaration that acquired characters were not inherited, and advanced the theory of the continuity and stability of the germplasm. This fascinating and minutely worked out scheme for advancing and clenching the argument for natural selection found many opponents and many ardent advocates. The battle was raged round the chromosomes as the center, and their intricacy and theoretical details were elaborated by Weismann and others until germplasm and somatoplasm, determinants, ids and idents were the stock in trade of every callow as well as learned biologist, in spite of the fact that these latter were unknown and unknowable. Indeed the whole fabric bid fair to break down by the very complexity of the concepts borne of an endeavor to imagine a machinery adequate to account for the increasingly intricate requirements of the known facts of heredity and evolution.

At the present time these terms have been in part abandoned and in part supplanted by others, but the pendulum had not only swung far to one side, but had actually advanced. This advance is probably best shown in the almost universal acquiescence at present in the idea that acquired characters are, at best, seldom inherited and that such cases are too few to be seriously considered as affecting greatly the trend of evolution.

But another, and perhaps more important gain was in the impetus given to the study of cytology, particularly the behavior of the nucleus, and the consequent marvelous improvement in the technique of the study of the chromosomes and the fascinating phenomena of fertilization and cell division. These are indeed important gains, however much the details of the Weismannian doctrine may be modified by subsequent discoveries.

But suddenly the pendulum began to swing the other way. Theodore Eimer in Germany vigorously, if somewhat unwisely, attacked the position of Weismann, being followed by others in Europe and by many of our own countrymen led by our famous paleontologist, Professor E. D. Cope. These latter formed what was then known as the "American School" of Neo-Lamarckians, who believed that acquired characters were inherited and that variations appear in definite directions and "are caused by the interaction of the organic being and its environment."

Few of the younger naturalists present can have any conception of the heat of the battle waged between the Neo-Darwinian and Neo-Lamarckian schools in the last decade of the nineteenth century. Professor Cope himself was a born controversialist and one of the most trenchant and quick-witted debaters among American biologists. Many of the older zoologists will picture to themselves his alert pose, his square-cut chin and the light of battle in his eye as he debated the question in meetings of this association; and discussed cat-

agenesis, kinetogenesis, physiogenesis, bathmogenesis and mnemogenesis.

The advance made by this Neo-Lamarckian swing of the pendulum was not so great nor so sure as its immediate predecessor. The battle in the main went against the Neo-Lamarckians. But they were a notable company, embracing many of the foremost names in the biological roster of that time. Such names as Hyatt, Cope, Dall, H. F. Osborn, Packard, Riley, Eigenmann and many others are significant of the standing of that notable group.

But there was some advance made by the Neo-Lamarckian swing. Cope's "law of the unspecialized" was a direct contribution to our understanding of the course, if not the cause, of organic evolution in its broader aspects; and Eigenmann's argument for the inheritance of acquired characters drawn from his masterly studies of blind vertebrates has not, so far as I am aware, been successfully controverted. To this day a very respectable body of zoologists are inclined to feel, deep down in their consciousness, that, as Geddes and Thomson say:

> It is idle to say that what living creatures do or fail to do has no racial importance.[1]

The remaining swing of the pendulum that demands our attention has just reached its maximum, and may well be designated as the "Mendelian swing." Not entirely Mendelian, either, but partly de Vriesian. This was in a direction tending to a wide departure from the position that had been taken by practically all workers since Darwin; *i. e.*, that natural selection had worked mainly, if not exclusively, by the gradual summation of small but appreciable individual variations. De Vries, with his famous evening primrose, had demonstrated, to his own satisfaction at least, that species arise by sudden mutations and thus sprung full-orbed into being and that ordinary variations never produced species by their summation. He claimed, however, that his theory was a direct contribution to Darwin's theory of natural selection.

At about the same time that de Vries was working with his primroses, the Austrian monk, Mendel, was working with sweet peas and made discoveries whose importance was not recognized until, in 1900, his results were verified by de Vries, Bateson and others in Europe and Castle, Davenport and others (a little later) in America. This was another epochal event in biological advance, and the scientific world was soon plunged into a warm discussion of the "Mendelian Law." Dominant and recessive, segregation, homozygotes and heterozygotes, determiners and factors, genotypes and phenotypes, were the order of the day. But worse was still to come. Factors of four kinds, determiners of three kinds, potencies of three kinds; then inhibitors to explain why the thing did not work. Allelomorphs, sex-limited inheritance and side chains, sweet peas and white mice, guinea-pigs and chickens, filled the circumambiant atmosphere. Biological laymen endeavored to steady their whirling brains while filled with admiration for the warm imagination of these new prophets. Intricate genealogical tables of new and fearful mien stared at us from blackboard, chart and printed page, and we tried, with indifferent success, to look intelligent.

Bateson, in his address as president of the Britsh Association, capped the climax when he added to the world-stupefying clamor of the opening war with the following verbal bomb:

> We must begin seriously to consider whether the course of evolution can at all reasonably be represented as an unpacking of an original complex

[1] "Evolution," 1911, p. 201.

which contained within itself the whole range of diversity which living things present.

Man simply an unpacked amœba! The mammal but a released protozoan! *Amœba proteus* a Prometheus bound! Not only the myriads of factors which represent "the whole range of diversity which living things present," but also the inhibitor for each waiting to assist in the unpacking and the thing that did the unpacking, all encompassed within the confines of a primordial cell! Also an implied super-Mosaic Diety that foresaw all this and did the original packing. The good old Presbyterian doctrine of foreordination absolutely outdone at last! Regeneration in its original theological sense biologically affirmed! And why not? Since we are told that unchastity in women is a unit character, chastity is attained by the miraculous release brought about by an inhibitor that is brought to a sense of its sinfulness and abandons its wicked ways; and the poor woman is started on the way to total sanctification!

Surely, we have now witnessed the extreme swing of the pendulum along the Mendelian path, and the reverse swing is due.

But no one will deny, all jesting aside, that real progress has been gained by the Mendelian swing, nor that this doctrine has contributed a distinct advance in our biological thinking. Few will fail to acknowledge that the factorial hypothesis explains much that has been obscure; that dominant and recessive are terms that will endure; that mutation will solve many a perplexing problem, possibly not of species in a state of nature, but surely of varieties under cultivation and of hybridization.

The idea of rhythm or swing has been in the minds of many thinkers. It is at the center of biological activities. Geddes and Thomson, in speaking of the historical oscillations between the mechanistic interpretation of the living organism and the vitalistic appreciation of it, say:

> Now it is a machine and again it is a spirit, now an automaton and again a free agent, now an engine and again an entelechy. The pendulum of thought continues to swing.[2]

Numerous illustrations of this biological rhythm will occur to each of us. Cell division and conjugation, medusa and hydroid colony, growth and reproduction, anabolism and katabolism, life and death. These are all swings of the pendulum. But there is also a steady advance. The life of the individual includes both swings, but there is also a real advance in the complexity of the species; and from these advances new species arise, whether by mutation or by the accumulation of variations.

The question as to what causes the advance will be answered when we at last find the real cause of evolution itself.

In contemplating this swinging and advancing pendulum of thought certain fundamental principles of wide application come to occupy the focus of attention:

1. While the pendulum swings regularly to right and left, it never actually retraces its course; but advances with each swing. There is a net gain which records definite progress, and this progress is, in general, along the line of evolution.

2. The extreme of each swing is actually further away from the real path of progress than the mean, away from the main direction of advance. The extremest is almost invariably wrong, in the main. He lets his imagination run away with him and carry him much too far, and the wise man will not follow him, but stops far short of the extreme and usually actually pulls back. This is the really valuable service of the conservative mass of thinkers in any

[2] "Evolution," 1911, p. 202.

province of thought; they tend to a return to the mean of wisdom and sanity. To change our simile for a moment, the extremist carries the ball far to the left or right in an end run; but he advances it somewhat, and the conservative mass of his colleagues brings the ball back to the center of the field and more directly in front of the goal.

It is almost hopeless to-day to look for a Weismannian in the extreme sense, but there is a practical acceptance of the idea of the continuity and stability of the germplasm. Probably no one now would give adherence to Cope's complete program, but many believe that, somehow, acquired characters play a real part in the advance of species. In my opinion, too, there are very few indeed who would frankly subscribe to the extreme of Bateson's doctrine regarding the unpacking process, but there are very many who admit that the Mendelian law is a very important thing in heredity, whether it really advances evolution or not.

3. We should be exceedingly hesitant in unreservedly condemning the leaders of the past, or the theories they advanced. Each one of them has done good service and each has been the vehicle of some important truth. Perhaps none of the theories advanced by Darwin has been so mercilessly ridiculed as that of pangenesis. Yet I find in one of the most recent utterances of T. H. Morgan the following:

> There is extensive evidence from cytology, experimental embryology and regeneration to show that all the different cells of the body receive the same hereditary factors.[3]

The swing of the pendulum back from the extreme position taken by Bateson has surely commenced, as the following quotations will show.

[3] "Mechanism of Mendelian Heredity," 1915, p. 42.

Castle, one of the leading American authors in Mendelianism, says:

> The more carefully we scrutinize the mutation theory the more serious do our doubts become, whether it is a secure foundation to build on, and again whether sport variation has had any part in the evolution of species is accordingly very doubtful.[4]

The veteran zoologist, Wm. H. Dall, says, in commenting on Bateson's address:

> We may admit the value of the Mendelian discovery in its relation to low and relatively simple organisms, like plants, and also that in higher organisms Mendelian effects can sometimes be traced, but that unbridled hypothesis should be permitted to cover our colossal ignorance is not what we expect from such a source. When the observed facts flatly contradict a hypothesis a truly scientific expositor says "I can not account for it," and does not cover up (to the lay mind) his ignorance by the phrase of "an inhibitory factor."[5]

No more honored name is at present on the roster of American biologists than that of E. B. Wilson, and the following quotation from him has a weight that all must recognize:

> And yet, as far as the principle is concerned, I am bound to make confession of my doubts whether any existing discussion of the problem affords more food for reflection, even to-day, than that contained in the sixth and seventh chapters of the "Origin of Species" and elsewhere in the works of Darwin.

The next swing of the pendulum lies in the immediate future, and we know not what it will bring forth; but we do know that it will be the means of a new advance along the road to a better understanding of nature's methods.

In the meantime, what should be the attitude of the systematist? Bateson would say that he is out of the game altogether, as the following quotation will show:

[4] SCIENCE, Vol. XLI., p. 98.

[5] SCIENCE, 1914, p. 245.

> Their (the systematists') business is purely that of the cataloguer, and beyond that they can not go.[6]

After full and calm reflection it seems to me that it is not too much to say that this utterance is proof positive that its author is hardly competent to pass an opinion on the work of his colleagues in other fields of biology however great his achievements in his own province. Castle expresses the following opinion:

> It is easy to dispose of the work of the systematist by assuming that he does not know his business, but is it wise to do so?[7]

As a matter of fact it seems to me that the systematist is affected not at all by Mendelianism. His species must be limited on phenotypic grounds alone, because the external appearance and morphology are all that can possibly be known of all but an infinitesimal fraction of the hundreds of thousands of species that must be dealt with. He cares little about what is done with domesticated animals, nor is he greatly interested in forms produced under abnormal conditions of captivity, cross fertilization or other forms of enforced biological immoralities. Of the 10,000 species of modern birds, for instance, how many can be established on factorial grounds? When it comes to the half million or so of insects, a few score, or perhaps hundreds of species might be worked out in the laboratory by Mendelian rules; but the laboratory conditions are usually highly unnatural, and it is safe to say that the results would be endless contradictions and confusion worse confounded; and the remaining hundreds of thousands of species would still have to be dealt with phenotypically or not at all.

So, too, with the innumerable marine forms of invertebrates, a single order of which is a man's job for a life-time, if he is to distinguish them phenotypically alone. The task is absolutely hopeless if treated genotypically.

The systematist knows that species differ from each other in very numerous small characters, and that, even if they would lend themselves to factorial analysis, the result would be much more perplexing than the present system which continually evokes the wrath of our nonsystematic colleagues.

Nor will our work be exclusively, or even mainly, that of the cataloguer. With the aid of our friends the morphologists, embryologists and paleontologists we will continue to unravel the tangled skein of descent; and our opinion will be valued in proportion to the honesty, patience and skill which we bring to our work, just as it always has been.

And so, I think, we can rest easy in the continuance of our job. Meanwhile we can greatly admire the man who busies himself with the microcosm of the cell, and bid him God-speed. We can contemplate with sympathetic delight the experimental zoologist as he shakes the eggs of the sea urchin and salts them with various kinds of salt.

We can even derive pleasure and much entertainment from the marvelous feats of our ultra-Mendelian friend, in full assurance that he will produce a factor that will meet every possible requirement; and that if he doesn't produce the factor he will have an inhibitor at hand to explain why the thing doesn't work. And we can rest calm in the faith that, if neither factor nor inhibitor is forthcoming, he will in no wise be abashed, but will calmly declare the form under scrutiny to be nothing but a fluctuating variety, and will smilingly cast it into the discard along with the systematist, who will just as smilingly proceed with his customary activities.

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[6] Science, August 14, 1914, p. 245.
[7] Science, XLI., p. 98.

ON THE NATURAL CHARGES OF METALS[1]

IN 1789 Bennett discovered that when two similar, insulated brass plates are placed very close together and parallel to each other and are simultaneously touched with pieces of different metal held in the hands they become charged relative to each other, and oppositely charged relative to the earth. Bennett gave the results of touching his plates with six different pairs of metals, and thus laid the foundation for what later came to be called the Volta contact series of metals. Bennett concluded as the result of his experiments that different substances have "a greater or less affinity with the electrical fluid," and he published a series of "Experiments on the Adhesive Electricity of Metals and Other Conducting Substances."

Bennett also tried the effect of touching one brass plate with a single metal while the other plate was parallel and very close to it but was joined to earth, and he found that his brass plate would take a positive charge when touched with lead ore, gold, silver, copper, brass, regulus of antimony, bismuth, tutenag, mercury and various kinds of wood and stone; but that it would take a negative charge from zinc and tin.

Six years later (in 1795) Cavallo published the results of a series of experiments on contact electrification. Cavallo placed a tin plate upon insulating supports and dropped a piece of metal upon it from the hand or from tongs or a spoon. He then tilted the tin plate and allowed the metal to slide off it, after which it was picked up and dropped onto the plate again. By sufficient repetition of this process, the plate became so highly electrified that the nature of its charge could be determined. Cavallo tried the effect of dropping his pieces of metal from a spoon or tongs of another metal, and made a large number of experiments upon the effect of heating or cooling the pieces of metal before they were dropped upon the tin plate. At the end of his experiments, he said, among his other conclusions:

> I am inclined to suspect that different bodies have different capacities for holding the electric fluid, as they have for holding the elementary heat.

In the meantime, Volta had discovered the existence of an electric current in a circuit made of two metals and a moist conductor. He first thought the source of the current to be in the surfaces of contact of the metals with the moist conductor, but later concluded that the current was not only originated, but was sustained, by the mutual contact of two metals of a different kind. In support of this conclusion, he published a series of experiments on contact electrification which were a virtual repetition of Bennett's experiments which had been published eight years before, but for which Volta gave Bennett no credit.

Meanwhile, in 1792, Fabroni had published his celebrated paper entitled "Upon the Chemical Working of the Different Metals upon Each Other at Ordinary Air Temperatures, and Upon the Explanation of Certain Galvanic Phenomena." In this paper Fabroni showed that the surface cohesion of different metals is changed merely by their mutual contact, so that metals which before contact were not attacked by the oxygen of the air or of water are readily oxidized when in contact with another less oxidizable metal. When Volta's discovery of the current was announced, Fabroni naturally concluded that the chemical action which took place at the surface of contact of at least one of the metals and the moistened membrane was the cause of the electrical current.

As a result of the controversy which followed regarding the source of the electromotive force in the voltaic current, a similar controversy arose over an entirely different question, viz., as to whether the transference of electricity from one metal to another as observed by Bennett and Cavallo was a primary phenomenon of metallic contact, or whether it was due to a preceding action of oxygen or some other element upon one or both of the metals. Ostwald, speaking of the theory of direct electrification by contact says:

[1] Read before a joint meeting of Section B of the American Association for the Advancement of Science and the American Physical Society, at Berkeley, California, August 5, 1915.

We stand at a point where the most prolific error of electrochemistry begins, the combating of which has from that time on occupied almost the greater part of the scientific work in this field.

This opinion has undoubtedly been shared by most chemists and by many physicists from that day to this.

It seems strange that those champions of the theory of the chemical origin of the contact charge who look upon Fabroni as the founder of their theory have overlooked the fact that what Fabroni especially undertook to show in his paper was that the mere contact of two metals weakens the cohesion between the molecules of at least one of them, and that this change was precedent to the chemical action which he regarded as the cause of the electrical current. Since we now know that cohesion is an attraction between the electropositive and electronegative ions of the metal, or more definitely, between the positive sub-atoms and the electrons within the metal, if we accept the foundation hypothesis of Fabroni we must conclude that the mere contact of two different metals produces a change in the electrical forces between their surface atoms before any chemical action is set up.

That this opinion was shared by Berthollet may be gathered from a translation in *Nicholson's Journal*[2] of a part of Berthollet's "Essai de Statique Chimique."

After a discussion of a number of experiments performed by Charles and Gay Lussac for the purpose of deciding whether the dissipation of a fine wire by the electric discharge of a Leyden jar was due to the heating effect of the spark or to some other cause, and their conclusion that the wire was not vaporized by heat, Berthollet concludes that the dispersion of the metallic particles precedes their oxidation, and says:

> Electricity favors this oxidation, inasmuch as it diminishes the force of cohesion; it is thus that an alkali renders the action of sulphur on oxygen much more powerful, by destroying the force of cohesion opposed to it, and that a metal dissolved in an amalgam is oxidized more easily than when it is in the solid state.

[2] Vol. 8, p. 80.

All the chemical effects produced in substances submitted to the action of electricity seem capable of being deduced from these considerations, and of being explained by the diminution of the force of cohesion, which is the obstacle to the combinations which their molecules tend to form.

The fundamental question at issue in the century-long battle which has been fought over contact electrification has been: Are the charges which are found upon two plates of different metals when they have been placed in contact and then separated due to some chemical action which has taken place at the time of contact, or were the two metals before they were brought into contact already electrically different with respect to each other? Or, since metals are said to be unelectrified when they have been put into good metallic contact with the earth while at a distance from other bodies, may two metals which are unelectrified with reference to the earth still be in different electrical states relative to each other?

Many physicists have maintained that two metals which have been discharged to the earth or to the inside of a hollow conductor are in absolutely the same electrical state, *i. e.*, that they are in a condition of absolute electrical neutrality. Others have believed that the change in the electrical state of both metals when they are brought into contact with each other proves that they were not in an electrically neutral condition before contact.

Among those who believe that before contact the metals are in an electrically neutral condition it is commonly held that the electrical displacement which occurs when two metals are brought into contact is due to the greater affinity of oxygen for one of the metals than for the other. Those who hold this view seem to overlook the fact that affinity for oxygen must be, itself, an electrical attraction. If zinc has an affinity for oxygen, it is because the zinc is either electropositive or electronegative to oxygen. If zinc has a greater affinity for oxygen than copper has, the zinc must be more electropositive or electronegative to oxygen than is copper, and in consequence it must be electropositive or electro-

negative to copper. This being the case, and both being conductors, they should when brought near together each induce a free charge upon the other.

This phenomenon was actually observed by Exner, who describes an experiment for showing it in *Repertorium der Physik*, XVII., 444 (1881). In this experiment a zinc plate was placed in a horizontal position, and after being discharged to earth was insulated. A similar copper plate could be lowered parallel to the zinc plate and very near it. This copper plate was earthed, then insulated and brought very near to the zinc plate and connected to an electrometer. This caused an electrometer deflection of + 9 scale divisions, due to the free charge induced upon the copper plate by the zinc. The copper plate and electrometer while still connected were earthed, and the electrometer deflection returned to zero. They were then again insulated, and while still connected, the copper plate was raised from the zinc plate. The electrometer then showed a deflection of — 9 scale divisions, due to the bound charge which had been induced upon the copper plate. After the copper plate was removed the zinc plate was tested and showed no free charge, it having been insulated throughout the experiment.

This seems to show conclusively that a zinc plate which has been discharged to earth and insulated is capable of inducing a free positive charge upon an insulated copper plate which is brought near it.

Exner also showed that when a platinum plate and a zinc plate, after having been discharged to earth and then insulated, are brought very near together each induces a free charge upon the other which may be shared with an electrometer. If the electrometer be connected first with the platinum plate it will show a positive charge. If the electrometer and plate be discharged to earth and again insulated and the electrometer connected to the zinc plate, it will show a negative charge. After this has been discharged to earth and the plate and electrometer again insulated the platinum will show another positive charge. In this way Exner was able to take twenty successive charges, alternately positive and negative, from his plates before their induced free charges were entirely discharged. This corresponds exactly to discharging the conductors of an insulated Leyden jar alternately.

The free charges induced by the approach of different metals to each other are discussed by Majorana in *Phil. Mag.*, XLVIII., p. 241, where they are called approach charges. Majorana also showed the attraction of one metal upon another at very small distances.

It is difficult to see how these induced charges can be accounted for by any chemical explanation. Neither can they be accounted for on the assumption of a double electric layer of any kind on the surface of the metal, since the distance between the positive and negative surfaces in such a layer would necessarily be so small that their differential effect would vanish at very small distances, and the induced charges may easily be observed when two plates of different metal are more than a centimeter apart. They may even be shown at much greater distances by using a hollow conductor of one metal and introducing the other metal into it. In this way an induced charge may be taken from the outer surface of the hollow conductor without bringing the two metal surfaces near together. In this case all talk of a double electrical layer is excluded, as is also any chemical action taking place within the hollow conductor after the inner metal is introduced.

This induced charge upon the outer hollow conductor may be shown even while the inner metal is in contact with the earth or with the inside of an earthed hollow conductor. A simple method of doing this is as follows:

A Dolazalek quadrant electrometer, *E*, in the diagram, is enclosed in a cage of fine wire mesh which is earthed through a wire soldered to the water system of the laboratory. The outer case of the electrometer and one pair of quadrants are connected to this cage. The other pair of quadrants is connected to a hollow metal cylinder, which may conveniently be about 15 centimeters long and 2 cm. in internal diameter. This cylinder, *C*, in the diagram, is supported horizontally upon hard rubber blocks inside the cage.

A round metal rod or tube, *R*, in the diagram, about one centimeter in diameter, is mounted in earthed metal guides which are concentric with the hollow cylinder, *C*. One of these guides passes through the wall of the wire cage, and is in metallic contact with it. A hole is cut in the cage opposite the other end of the hollow cylinder, so that the rod can be pushed concentrically through the hollow cylinder without touching its walls. The rod is thus always in contact with the cage which forms the earthed hollow conductor, and the part of it within the hollow cylinder is also within this earthed hollow conductor and in metallic contact with its walls.

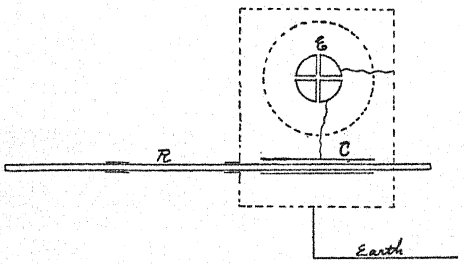

Fig. 1.

Before beginning an experiment, the needle of the electrometer, which was suspended by a quartz fiber, was charged from 200 dry cells and then insulated. The hollow cylinder, *C*, was then put in contact with the outer cage so that the free charge induced upon it by the electrometer needle might be taken off. When, now, the earthed rod was pushed through the cylinder, a charge was induced upon the cylinder which varied with the metal of the rod. Thus when a compound rod consisting of rods of the same diameter of zinc and copper put together, end to end, was pushed through the cylinder, the electrometer needle was differently deflected according as the zinc or copper part of the rod was in the cylinder. Thus in one experiment the copper part of the rod was pushed through the cylinder *C*, which was then discharged to the cage and again insulated. The zinc part of the rod was then pushed into *C*, and the electrometer showed a deflection of 12.5 scale divisions. This was repeated regularly many times. When the whole rod was withdrawn from the cylinder and an insulated copper rod of the same diameter was substituted for it and was alternately connected to the zinc and the carbon of a single dry cell, the electrometer gave a difference of scale reading of 35 scale divisions. Since the electromotive force of the dry cell used was about 1.25 volt, the difference of deflection for the zinc and copper ends of the rod indicated a difference of electric state of about .4 volt, the zinc being electropositive to the copper. This difference remained unchanged when the rod was in contact with the outer cage on both sides of the cylinder *C*.

By substituting an induction cylinder only 2.5 cm. long for *C*, it was found that the zinc was most electropositive next to the copper, and that its electropositive charge decreased gradually with the distance from this junction.

It has been known since the experiments of Cavallo that the contact charges of two metals depend upon their temperature. Since the contact charges which have been observed from Bennett's time on are apparently the bound charges induced by the two metals upon each other when close together, it was to be expected that the charges which metals hold while in contact with the earth or with the inside of a hollow conductor should vary with the temperature of the metal. By heating one section of a rod of a single metal and cooling another section, this expectation was verified. Thus, in the case of iron, steel, copper, brass and tin, the warmer part of the rod was electronegative to the colder part; in aluminium the warmer part became markedly electropositive, while in zinc the change was very slight.

Since the Thomson effect in iron indicates a change in the direction of the electromotive force at the junction of a hot and a cold part at about 150 degrees, an attempt was made to heat one end of a steel tube and keep the other end cold and measure the change of induced charge with a change in temperature. It was found that the tube used became more electronegative as its temperature increased up to 150 degrees, or more. From 150 to 200 de-

grees the electric charge of the metal changed very little, but beyond 200 degrees the tube became more electropositive with an increase in temperature. It was impossible to measure the induction of the tube much beyond 200 degrees, since at higher temperatures the hot tube ionized the air and allowed the induced charge of the cylinder to discharge to the tube.

It is interesting in this connection to note that the internal cohesion of iron and steel seems to change with a change in the fixed electric charge of the metal. In a paper on "Contact Electromotive Force and Cohesion" written several years ago it was shown that when the metals are arranged in their proper order in the contact electromotive series they are arranged in the inverse order of their cohesion, so that the more electronegative a metal is in the contact series the greater is its cohesion. Since in the case of the steel tube used in the experiment described above the metal became more electronegative up to a temperature of about 150 degrees, it would seem to be a legitimate deduction that the tensile strength of the tube should increase up to this temperature and then begin to decrease with a rise of temperature.

In a series of experiments made by C. Bach and described in *Zeitsch. d. Deutsch. Ingénieure,* 1904, p. 1300, the tensile strength of iron was actually found to be much greater at 200 degrees than at 20 degrees. From 200 to 300 degrees it decreases, but it is still greater at 300 degrees than at 20 degrees. At 400 degrees it is only a little less than at 20 degrees.

In the *Valve World* of January, 1913, is an article by I. M. Bregowski and L. W. Spring on "The Effect of High Temperatures on the Physical Properties of Some Metals and Alloys." In this article it is shown that samples of cast iron, both soft and hard, have a greater tensile strength at 300° F. than at 70° F., and that at 750° F. the tensile strength is still within one per cent. of as great as it is at 70° F. In the case of a sample of Crane Ferrosteel the tensile strength is greater at 750° F. than at 70° F.

In a dissertation by A. Lantz, entitled "Einwirkung der Temperatur auf die Biegfähigkeit von Flusseisen und Kupferdraehten," Berlin, 1914, the author finds that what he calls the *Biegfähigkeit* of iron, *i. e.,* its malleability or toughness as measured by the number of times it can be bent short forward and backward at a given point before breaking, increases with the temperature to about 220 degrees and then decreases. In some cases the wire would stand twice as many short bendings at 220 degrees as at room temperature, while at 350 degrees it would stand only one fifth as many as at room temperature. The toughness of copper measured in this way continued to increase to 320 degrees, which was the highest temperature of the experiment.

The above mentioned experiments all seem to indicate that the cohesion of iron increases with its increase of temperature so long as the iron continues to become more electronegative, and that the cohesion begins to decrease at about the temperature at which the iron begins to lose its negative charge.

This is what we should expect if cohesion is an attraction between positive and negative charges. An increase of cohesion would then mean a greater attraction of the positive sub-atoms of the metal for movable electrons and a consequent increase of the negative charge of the metal. So far as we know, such a change in the attraction of the positive sub-atoms for electrons can be brought about only by a change in the specific inductive capacity of the metal.

It would seem that all known phenomena of contact electrification may best be explained on the hypothesis that different metals when in electrical contact with the earth or with the inside of a hollow conductor, although by definition at zero potential, still actually retain characteristic charges which are capable of inducing a charge upon a different metal when brought near it. It is these characteristic charges which I have ventured to call the natural charges of the metals.

When two metals are brought near together while in electrical contact with the earth, their natural charges are increased or diminished by the bound charges due to their mu-

tual induction. If insulated while in this position and then separated, the whole or a portion of their bound charges become free charges. If while separated they are electrically connected with the earth, such a transference of electricity will take place between each of them and the earth as will restore their original fixed charges.

Since a metal within a hollow conductor of another metal is wholly within the field of induction of the outer metal, the fixed charge which the inner metal will take when in contact with the outer will be determined to the greatest possible extent by the bound charge induced by the outer metal. Accordingly, this will, in general, be different from the fixed charge which the inner metal will take in the earth's field alone. It follows from this that when two metals inside a hollow conductor are brought into contact with each other and with the outer hollow conductor, the bound charges which they acquire are partly due to their mutual induction and partly to the induction of the outer hollow conductor. If they are flat plates and are placed parallel and very close together when touched to the outer conductor, their bound charges may be quite largely due to their mutual induction; if they are spheres with their surfaces touching while they are put into contact with the outer conductor, their bound charges will be determined principally by the induction of the outer conductor.

Thus, a zinc ball about 5 centimeters in diameter was insulated by a silk thread and was lowered into a metal beaker of 750 c.c. capacity until it touched the bottom. It then held the fixed charge due to the induction of the surrounding beaker. When it was lifted out of the beaker, this charge became free, and could be shared with an electrometer. The tilted gold leaf electrometer of C. T. R. Wilson was used on account of its small capacity.

The difference in the gold leaf deflection due to twenty successive charges from the inside of the bottom of a copper beaker and to the same number of charges from the inside bottom of an exactly similar aluminium beaker was 20.8 scale divisions, when the sensitivity of the instrument was 14 scale divisions for an ordinary dry cell.

A disc of tinfoil a little larger than the bottom of the beaker was then pressed down into each beaker until it rested on the bottom and was turned up about a centimeter around the inside of the beaker. The zinc ball was then charged as before by contact with the tinfoil instead of the metal of the beaker. As a mean of twenty such readings for each beaker made exactly as before the electrometer deflection amounted to 20 scale divisions for the difference of charge taken from the tin foil inside the two beakers. This showed that the fixed charges induced upon the zinc ball were due almost wholly to the outside beakers instead of the inside tinfoil.

The beakers were then inverted and the tinfoil discs were placed on the outside of their bottoms and the zinc ball charged by contact with the tinfoil as before. Here, where inductive influence of the beakers was almost wholly removed, the difference of the charges taken from the tinfoil discs averaged only 1.2 scale divisions, which was not greater than the probable error of the experiment.

A third series of readings was then made with the beakers loosely wrapped on the outside with tinfoil which was turned in for a centimeter or so around the top. The zinc ball was lowered into the beakers and charged by contact with the bottom, as in the first series of experiments, both with the tinfoil around the beakers and with it removed. In this series, the difference in deflection due to the two beakers without the tinfoil was 23.4 scale divisions, while with the beakers wrapped in tinfoil it was only 7.5 scale divisions. In this case, since the bound charges induced by the tinfoil wrapping upon the two beakers were different from their normal fixed charges, the charges which they, in turn, induced upon the zinc ball were also different from the charges which they induced with the tinfoil wrapping removed.

Summary

I have tried to show in the preceding paper that metals, and probably all other bodies,

when in electrical contact with the earth still retain characteristic charges which are capable of inducing electric separations in other bodies brought near them.

That when two metals are brought near together, their induced free charges will escape to the earth or to any other conductor with which they may be in metallic contact.

Their bound charges remain in or on the metal. If after their free charges have escaped the metals be insulated and then separated, the bound charges become free, and are the so-called contact charges of Bennett and Cavallo.

The magnitude of the natural charge of a metal seems to be determined by its internal cohesion, and hence presumably by its specific inductive capacity. Whatever changes the specific inductive capacity of the metal, or even of its surface, will accordingly produce a change in the fixed charge of the metal.

This point of view consists merely in introducing the earth into the contact series. It seems certain that the same metal will hold different charges when in contact with different parts of the earth, as it will when in contact with the interiors of different hollow conductors.

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THE FIRE AND THE MUSEUM AT OTTAWA

THE Museum of the Geological Survey, Ottawa, Canada, is to Canada practically what the National Museum is to the United States and the British Museum to the United Kingdom. This museum has been greatly affected by the fire which, beginning about 9 P.M., Thursday, February 3, 1916, destroyed the Dominion Parliament building and caused the loss of several lives. Before 2 A.M., February 4, while the flames were still spreading, a member of the cabinet was considering the use of the large auditorium in the Victoria Memorial Museum building as possibly a suitable place for the meetings of the House of Commons, and members of the Geological Survey were holding themselves in readiness to clear any of the other space necessary. It will be remembered that this museum building was the home of the Geological Survey of Canada and the temporary quarters of the National Gallery of Canada. It was open to the public from nine till five daily except Sundays, Christmas day and Good Friday, and from two till five on Sundays during the winter.

On the ground floor were the central hall, usually with special and timely exhibits, the main floor of the auditorium, the west hall with tentative mineralogical exhibits, the west wing for geology, but containing boxed specimens and camp equipment, the east hall with invertebrate paleontological exhibits, and the east wing with tentative exhibits of vertebrate paleontology.

On the first floor were the tower hall with some ethnological specimens, the lecture hall gallery, the west hall—three fourths devoted to tentative archeological exhibits and one fourth occupied by entomological exhibits—the west wing with permanent archeological and ethnological exhibits, and the east hall with zoological exhibits. On this same floor the east wing was occupied by Canadian pictures, and Greek, Roman and Italian renaissance sculpture, of the National Gallery. On the second floor were most of the offices and the library of the Geological Survey, and in the northeastern room of the east hall an office of the National Gallery. On the same floor the east wing was occupied by Medieval and French renaissance sculpture, Royal Canadian Academy Diploma Pictures and colored prints of the world's most famous pictures, of the National Gallery. On the third or top floor were offices, the much used though small and tentative museum lecture hall, the gallery of the library, the drafting room, study and storage rooms. On this floor the east wing was occupied by the oil and water colors, prints, etchings, drawings and bronzes of the National Gallery. In the basement were work shops, laboratories, distribution offices, photographic department, and half a hall devoted to a workshop of the National Gallery.

The Geological Survey, it may be seen, oc-

cupied practically all the building except the three and a half floors in the east wing and an office which were used by the National Gallery. Each hall and wing is practically one hundred and twenty feet long by sixty feet wide. The central hall was temporarily vacant and here the post office for the House of Commons, telephones, and two telegraph offices were installed before noon, or within less than fifteen hours after the fire started.

About ten A.M., February 4, the morning of the fire, the survey staff was informed of the intended use of the building as a temporary home for the Dominion Parliament. The large auditorium with its gallery, which was only partially furnished and had been but little used for lectures, was immediately released from museum uses and prepared by the Department of Public Works, so that the House of Commons was enabled to begin its session at 3 P.M. or in less than twenty hours after its deliberations had been disturbed by the fire. The throne, used by the Governor-General in the privy-council room, which was rescued from the fire, served for the speaker of the House of Commons. A press gallery was built back of the speaker.

The west hall was occupied by the tentative exhibit of minerals. This exhibit was packed and removed in six hours or by 4 P.M., Friday, which was less than twenty hours after the fire began. The costly cases in which these minerals were exhibited had meanwhile been taken apart and placed in storage. Rooms for the members of the Senate were made here.

The west wing, which was being prepared for geological and mineralogical exhibits, was cleared before Monday noon. The southern half of this hall was decorated, carpeted with the traditional scarlet carpet, and furnished with furniture, most of which had been saved from the Senate chamber. The walls were hung with portraits also rescued from the chamber, placed in order, King George III. and Queen Charlotte leading the others, which consist of the portraits of the speakers of the Senate, ranged in the order of precedence. The Senate met at 8 P.M. on Tuesday in this new chamber within seventy-five hours after it became known that the Senate would meet in the museum. North of the aisle the Senate Post Office and other rooms for their convenience have been built.

The east hall with invertebrate paleontological exhibits, similar in size to the other exhibition halls, contained thousands of small and delicate specimens. These were all carefully wrapped, packed and taken away. The work of dismantling had progressed so far by midnight or within twenty-eight hours after the origin of the fire, that the Public Works carpenters were enabled to begin erecting the walls of the offices for the convenience of the members, and twelve hours later or forty hours after the beginning of the fire all the museum specimens and cases had been moved from this part of the building, which was made into offices for members of the House of Commons.

Of the east wing containing tentative vertebrate paleontological exhibits, three quarters were cleared and these exhibits were stored, with those of the other quarter, along the walls of the southern half of the hall. This clearing involved not only the moving of small exhibits in cases, but also of such heavy fragile specimens as the titanotherium and the skulls of dinosaurs and mammoths, yet it was all done within two hours after this notification, that is by noon, or in less than twenty hours from the time that the fire broke out.

The ethnological specimens were taken out of the tower hall, which was then fitted up and used before Friday noon as a newspaper library corresponding to the one where the fire originated.

Before noon, that is within less than two hours after notice, the tentative exhibit of Canadian archeology in seventeen cases, covering three quarters of the west hall, was cleared of specimens and cases, while the tables upon which the cases stood were left for the use of the members of parliament. The specimens were transferred to sixty-eight trays and stored in the archeological laboratory in the basement. Meanwhile the remaining quarter of the hall had been cleared of a tentative exhibit of entomology in four cases. In this hall a place for the press gallery staff

to work, various offices for members of the senate, and offices for the Hansard staff which records the deliberations of the house were made ready before Monday noon.

The exhibits in the permanent anthropological hall were left intact. Besides the exhibits the archeological specimens in storage under the exhibition cases were also undisturbed. The ethnological exhibits which are of specimens from the Eskimo, the Indians of the northwest coast of America and the Algonquian and Iroquoian Indians of the eastern woodlands, were undisturbed. The aisles in this hall, however, were used for storing furnishings and specimens from various other departments and for office space for the ethnologists.

The zoological hall, similar in size to the others, was cleared by Sunday noon. This necessitated the taking apart of splendid large group cases and the dismantling of groups of seals, mountain goat, mountain sheep, musk oxen and various other exhibits and the removal to storage in the aisles of the anthropological hall of the smaller cases containing exhibits of mammals, birds and reptiles. The space was divided up into offices for the members of the House of Commons.

The offices on the second floor were promptly vacated with the exception of two, that of the curator and mineralogist and that of the vertebrate paleontologist. The invertebrate paleontological offices were moved to the third floor. The archeological office was moved to smaller space in the entomological laboratory on the third floor, all specimens being taken to the laboratory. The known loss to archeological specimens caused by the move from both office and tentative exhibition is negligible, the damage being less than one dollar. Work on monographs will be hampered for lack of space to spread out the material for study, but every specimen is still available, on permanent exhibition, in storage under the exhibits, or in the laboratory where aisles allowing for the free passage of trays are maintained, though the storage reaches the ceiling in most of the remaining space. The ethnological office was moved into the south end of the anthropological exhibition hall and the botanical office was moved into the botanical herbarium on the third floor. The library was not disturbed. The vacated rooms were at once occupied chiefly by the Cabinet and other members of the House of Commons.

The offices, drafting room, workshops and storage on the third floor, were mostly retained, but the little lecture hall was released. The lectures in course were postponed indefinitely. The zoological study material and the herbarium were undisturbed. The physical anthropological office was concentrated into about half its former space, and an ethnological storage room was vacated.

In the basement the workshops and laboratories were mostly retained, as were the taxidermist department, the laboratory of vertebrate paleontology, the photographic department, and half a hall devoted to the workshop of the National Gallery. Some work rooms were vacated, however, and the distribution offices with their vast store of publications and maps were moved to another part of the city.

Of about a hundred and forty members of the survey staff over seventy moved about a mile to a series of buildings recently taken over by the government on the north side of Wellington Street between Bank and Kent Streets, while some sixty of those most intimately connected with museum work retained room in the Victoria Memorial Museum building. In this work of moving, militia motor lories were pressed into service, as well as sleighs and other transports, and the office furnishings and working specimens went out at the rate of sixty loads in one day.

The National Gallery of Canada turned over all its premises except two rooms, one on the first floor and one on the second, in which the art objects were compactly stored. It retained its offices and workshop. Thus it turned over about five sevenths of its space. The director of the gallery was called upon and he directed the hanging of pictures in the part of the building occupied by parliament and with his staff assisted in rescuing pictures from the parliament building. These activities afford an example of museum usefulness.

The Survey staff made space faster than it was required, always managing to keep ahead of the Public Works men. Under the direction of Hon. Robert Rogers, minister of public works, Mr. J. B. Hunter, deputy minister, Mr. John Shearer, superintendent of buildings, and their various assistants, the Public Works staff prepared the building for parliament by building walls, decorating, carpeting, installing telephones, two telegraph offices, two post offices and many other necessities and conveniences. They also provided facilities for those of the Survey staff remaining at the museum to carry on its work.

His Royal Highness, the Governor-General, inspected the House of Commons and the other parts of the Victoria Memorial Museum building turned over for the use of parliament at eleven A.M. on Monday, less than eighty-seven hours after the fire began or less than seventy-four hours after the museum authorities were notified of need for the space. He was apparently much pleased at the speed with which the survey staff had made room and with the facilities and comforts so hastily installed by the Public Works staff.

The museum retains intact only one and a quarter of the exhibition halls, namely, the anthropological hall and part of the hall of vertebrate paleontology. It is closed to the public, admission being by pass only.

A sample museum, by means of which to advance museum interests in the Dominion, has been begun in the anthropological hall. The archeological and ethnological exhibits are intact, some of the best zoological exhibition cases of birds, reptiles and insects, have been placed in the wider aisles where they may be viewed, while mounted mammals and skeletons of various animals have also been placed in the aisles and on top of the cases. In the unoccupied space of this character, and in such other space as may be made by storing all but a representative archeological series, still other exhibits may be placed.

On the whole the scientific work of the museum may go on practically unhampered. The lecture work is being carried on in other auditoriums. The exhibitions eventually may be facilitated by the present apparent set back, as the museum staff is undiscouraged, and the members of parliament, who are now in daily proximity to the exhibits and constantly meeting museum workers, may become so interested that they will provide future facilities for museum work in the Victoria Memorial Museum building or in a building even better adapted for museum purposes. Besides this they may carry home to all parts of the Dominion inspiration to establish useful museums and to improve those already in existence.

Harlan I. Smith
Museum of the Geological Survey,
Ottawa, Canada

ROBERT JAMES DAVIDSON

Robert James Davidson closed his earthly career suddenly December 19, 1915, leaving a beautiful and beneficent memory. Born at Armagh, Ireland, April 3, 1862, he attended schools near Liverpool, England, and came to this country as a youth. He was educated at South Carolina College and University, from which he received the degrees of Bachelor of Science and Master of Arts and in whose faculty he served for some six years. This preparation was to bear ripe fruit in the career which really commenced in 1891, when he was called to the chair of chemistry in the Virginia Polytechnic Institute at Blacksburg, Virginia. For nearly a quarter of a century he labored there teaching chemistry, administering the discipline of the college as professor and as dean, leading the farmers of the state with admonition and advice, and always ready to serve. One invariably thinks of the word *service* in remembering Davidson. It gives the keynote to the song of his life. Whether with his students, his colleagues, or his fellow-citizens, in fact with his neighbor wherever he met him, Davidson's first and main thought was to be of service and truly did he follow, far more closely than the average man, the example set by the Master nineteen hundred years ago. He was fearless in this service, never hesitating to state his objection to argument or his adverse opinion with the reasons

therefor, and this when he thought need be, whether or not it gave annoyance or even pain. But with this fearlessness to serve in the truest sense, was combined a gentleness that made his personality a strongly marked one in whatsoever society he chanced to be. For many years a sufferer from bodily pain, he went uncomplainingly, fearlessly but gently, keeping a lookout for opportunities to serve. A charming host to the stranger on the campus and to his colleagues, he was a big brother to every student who claimed his aid or would let himself be helped, and many a man has left the college the better for the glimpse of tender family love and gentleness which pervaded his hospitable home.

It was among his scientific colleagues, perhaps, that Davidson's personality stood forth most clearly defined. His attainments won recognition and he held a high place among the notable men of several important scientific organizations. He was a fellow of the American Association for the Advancement of Science, a member of the American Chemical Society, the Association of Official Agricultural Chemists, and the Washington Academy of Sciences. He was frequently chosen a delegate to important gatherings, as for instance, the International Congress of Applied Chemistry at London, and in 1903 he served as president of the Association of Official Agricultural Chemists. Never afraid to raise his voice for the truth as he saw it, always gentle and considerate of adversary or controversialist, ever anxious to compose differences of opinion and especially of feeling between opponents, and a faithful attendant at meetings, Davidson's membership in numerous and important committees was logical and inevitable. And these committees he served with his whole heart and his whole strength. It had a profound effect on his scientific life. With a strong mentality, wide and deep reading, a cheerful readiness amounting to eagerness to hear or learn of the work of others, and a patient and diligent effort to assimilate new ideas, he should have been a notable man in chemical research. While his contributions in this field, especially in the application of chemical ideas to the problems of soil management and farm practises are worthy of high praise, it was not humanly possible for any one to give to his college duties, to his work among farmers, and to his committee duties, the time and energy that Davidson gave, and at the same time gain unusual distinction in a specialized field of science. But fame was truly appraised by Robert James Davidson as of lesser importance than duty and the opportunity to serve. Though his name may not be remembered as linked with some particularly important milestone in the history of science, yet it will be remembered long, tenderly, and reverently, not only as a faithful worker in science, but as the man and the brother and a model in all the activities of a good citizen for his colleagues and his neighbors. Agricultural science has lost one of her most notable American pioneers and her most faithful servants.

FRANK K. CAMERON

THE ROCKEFELLER FOUNDATION AND THE GENERAL EDUCATION BOARD

ANNOUNCEMENT is made of the annual election of officers of the Rockefeller Foundation. President John D. Rockefeller, Jr., and Secretary Jerome G. Greene were reelected. The executive committee is now John D. Rockefeller, Jr., Simon Flexner, Starr J. Murphy, Wickliffe Rose and Jerome D. Greene. The finance committee is John D. Rockefeller, Jr., A. Barton Hepburn and Starr J. Murphy. The Foundation has elected as new trustees, Martin Antoine Ryerson, of Chicago; the Rev. Dr. Harry Emerson Fosdick, of Montclair, N. J., and Frederick Strauss, of New York. Mr. Ryerson is president of the board of trustees of the University of Chicago. The Rev. Dr. Fosdick is pastor of the First Baptist Church, Montclair, and the Morris K. Jesup professor of practical theology in the Union Theological Seminary.

From the trustees of the estate of Mrs. John D. Rockefeller, Sr., the foundation has received a gift of $49,860, which is in addition to a previous gift from Mrs. Rockefeller's estate of

$340,874. The capital fund of the Foundation on January 1, 1915, was $100,048,000.

Appropriations amounting to $1,200,000, not hitherto announced, have recently been made by the Foundation. To the Rockefeller Institute for Medical Research is given $1,000,000 for additional endowment needed in connection with the Department of Animal Pathology, recently established near Princeton, N. J. To the Rockefeller Institute for Medical Research, $25,000 goes for the cost of medical research and such medical supplies and services as the institute may appropriately furnish at the seat of war in Europe. Most of this appropriation will be used for the support of the research and hospital work being conducted by Dr. Alexis Carrel in France. The China Medical Board receives $125,000 for the purchase of additional property adjoining the Union Medical College in Pekin for the promotion of medical teaching in China. The international committee of the Young Men's Christian Association receives $50,000 in support of the work in the military prison camps of Europe.

The General Education Board, founded by John D. Rockefeller "to promote education within the United States" without distinction of race, sex or creed, will shortly issue its complete annual report for the fiscal year 1914–15.

The first installment of that report, made public this week, shows that since its organization and up to June 30, 1915, the board had appropriated directly $16,862,147.71. Of this amount, $10,848,084.07 had been paid out, and $6,014,063.64 was awaiting requisition.

Up to that date the board had appropriated its entire accumulated income with the exception of $198,992.35.

The report shows the value of the board's resources, supplied by Mr. John D. Rockefeller, to be $33,958,848.40, of which $30,918,063.80 is general endowment and $3,040,784.60 reserve fund.

The gross income from these funds for 1915 was $2,230,425.41. In addition, the Anna T. Jeanes Fund, which is administered by the board, yielded an income of $7,910.46. The administration of these funds is in the hands of a board of trustees consisting of Frederick T. Gates, chairman; Walter H. Page, John D. Rockefeller, Jr., Albert Shaw, Wallace Buttrick, Starr J. Murphy, Edwin A. Alderman, Hollis B. Frissell, Harry Pratt Judson, Charles W. Eliot, Andrew Carnegie, Edgar L. Marston, Wickliffe Rose, Jerome D. Greene, Anson Phelps Stokes, Abraham Flexner and George E. Vincent.

The General Education Board's appropriations up to June 30, 1915, had been as follows:

Universities and colleges for whites for endowment	$11,672,460.16
Medical schools	2,670,874.11
Colleges and schools for whites, for current expenses	159,991.02
Colleges and schools for negroes	811,781.13
Southern Education Board	97,126.23
Salaries and expenses professors of secondary education	275,580.01
Salaries and expenses supervisors negro rural schools	84,320.57
Salaries and expenses rural school agents	70,645.77
Farmers' cooperative demonstration work in south	716,077.80
Farmers' cooperative demonstration work in Maine	45,173.67
Farmers' cooperative demonstration work in New Hampshire	24,593.49
Girls' canning and poultry clubs in south	113,751.52
Girls' and boys' clubs in Maine	11,205.12
Rural organization work	36,646.83
Conferences	18,420.28
Educational surveys	32,500.00
Home Makers' Club agents in southern states (colored)	15,000.00
Rural education	6,000.00
	$16,862,147.71

CENTENNIAL OF THE COAST AND GEODETIC SURVEY

Exercises in celebration of the hundredth anniversary of the establishment of the United States Coast and Geodetic Survey will be held on Wednesday, April 5 and Thursday, April 6. The program is as follows:

Afternoon of April 5, at the New National Auditorium, Washington, D. C. Beginning at 2:30 p.m.

Dr. Hugh M. Smith, Commissioner of the United States Bureau of Fisheries: "The Bureau of Fisheries and its Relation to the United States Coast and Geodetic Survey."

Dr. Louis A. Bauer, Director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington: "The Work Done by the United States Coast and Geodetic Survey in the Field of Terrestrial Magnetism."

Dr. S. W. Stratton, Director of the United States Bureau of Standards: "The Bureau of Standards, and its Relation to the United States Coast and Geodetic Survey."

Rear Admiral J. E. Pillsbury (Retired), United States Navy: "Ocean Currents and Deep Sea Explorations of the United States Coast and Geodetic Survey."

Dr. George Otis Smith, Director of the United States Geological Survey: "The United States Geological Survey and its Relation to the United States Coast and Geodetic Survey."

Evening of April 5, at the New National Auditorium, Washington, D. C. Beginning at 8:00 p.m.

Hon. J. Hampton Moore, Member of the United States House of Representatives: "The United States Coast and Geodetic Survey's Part in the Development of Commerce."

Brigadier General W. M. Black, Chief of Corps of Engineers, United States Army: "The United States Corps of Engineers and its Relation to the United States Coast and Geodetic Survey."

Hon. George R. Putnam, Commissioner of the United States Bureau of Lighthouses: "The Lighthouse Service and its Relation to the United States Coast and Geodetic Survey."

Mr. George Washington Littlehales, Hydrographic Engineer, United States Hydrographic Office: "Hydrography and Charts with Special Reference to the Work of the United States Coast and Geodetic Survey."

Afternoon of April 6, at the New National Auditorium, Washington, D. C. Beginning at 2:00 p.m.

Professor William Henry Burger, Professor of Civil Engineering, Northwestern University: "The Contribution of the United States Coast and Geodetic Survey to Geodesy."

Rear Admiral Richard Wainwright (Retired), United States Navy: "The Civil War Record of the United States Coast and Geodetic Survey, and What the Survey is Doing towards Preparedness."

Dr. Otto Hilgard Tittmann, President of the National Geographic Society: "The International Work of the United States Coast and Geodetic Survey."

Dr. Charles Lane Poor, Professor of Celestial Mechanics, Columbia University: "Oceanic Tides with Special Reference to the Work of the United States Coast and Geodetic Survey."

Dr. Douglas Wilson Johnson, Associate Professor of Geology, Columbia University: "The Contribution of the United States Coast and Geodetic Survey to Physical Geography."

Evening of April 6, Banquet at the New Willard, Washington, D. C. Beginning at 8:00 p.m.

Speakers: The President of the United States, The Minister of Switzerland, The Secretary of the Navy, The Secretary of Commerce, Dr. Thomas Corwin Mendenhall. The first superintendent, Professor Hassler, was a native of Switzerland. Doctor Mendenhall is the oldest living ex-superintendent.

Exhibit of the United States Coast and Geodetic Survey at the New National Museum, Washington, D. C. Wednesday, April 5, 1916. Open 10 a.m. to 11 p.m. and Thursday, April 6, 1916. Open 10 a.m. to 6 p.m.

This exhibit will consist of surveying instruments and appliances, pictures of surveying operations and equipment; charts and other publications of the bureau. As far as possible the earliest instruments and appliances which were used by this bureau will be exhibited beside those now in use. The earliest maps and charts of the United States which can be obtained will be shown for comparison with the present charts issued by the bureau.

The superintendents of the Coast and Geodetic Survey and the periods during which they served are as follows:

Ferdinand Rudolph Hassler	1816–1843
Alexander Dallas Bache	1843–1867
Benjamin Osgood Peirce	1867–1874
Carlile Pollock Patterson	1874–1881
Julius Erasmus Hilgard	1881–1885
Frank Manly Thorne	1885–1889
Thomas Corwin Mendenhall	1889–1894
William Ward Duffield	1894–1897
Henry Smith Pritchett	1897–1900
Otto Hilgard Tittmann	1900–1915
Ernest Lester Jones	1915–

SCIENTIFIC NOTES AND NEWS

Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, will give the William Ellery Hale Lectures at the approaching meeting of the National Academy of Sciences. The subject is "The Origin and Evolution of Life on the Earth."

The following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Professor E. H. Barton, Mr. W. R. Bousfield, Mr. S. G. Brown, Professor E. G. Coker, Professor G. G. Henderson, Mr. J. E. Littlewood, Professor A. McKenzie, Professor J. A. MacWilliam, Mr. J. H. Maiden, Professor H. H. W. Pearson, Professor J. A. Pollock, Sir L. Rogers, Dr. C. Shearer, Professor D'Arcy W. Thompson, Mr. H. Woods.

It is stated in *Nature* that Mr. Douglas W. Freshfield, president of the Royal Geographical Society, M. Henri Curdier, the French Orientalist, and General Schokalski, the Russian oceanographer, have been elected honorary members of the Italian Royal Geographical Society.

The Accademia dei Lincei of Rome has awarded the King's prize of £400 for human physiology to Dr. Filippo Bottazzi, professor of physiology in the University of Naples.

Dr. George Sarton, who is now lecturing in the United States on the history of science, the former editor of *Isis*, an international review devoted to the philosophy and history of science, published in Belgium, but discontinued during the war, has been awarded the Prix Binoux by the Paris Academy of Sciences.

Professor Metchnikoff has been seriously ill at the Institut Pasteur. Sir Ray Lankester writes to *Nature* under date of February 26 that his medical attendants believe that the pleurisy will now soon disappear and that the pulmonary congestion has already disappeared.

The city of Philadelphia, acting on the recommendation of the Franklin Institute, has awarded the John Scott Legacy medal and premium to Hans Hanson, of Hartford, Conn., for his inventions embodied in John Underwood and Company's combined typewriting and calculating machine, and has also awarded the John Scott Legacy medal and premium to Frederick A. Hart, of New York, N. Y., for his inventions embodied in the same machine. In consideration of the part performed by the staff of John Underwood and Company in the development of this machine, The Franklin Institute has awarded its Edward Longstreth medal of merit to John Underwood and Company, of New York, N. Y.

The prize of $1,000 offered through the American Social Hygiene Association by the Metropolitan Life Insurance Company for the best pamphlet on social hygiene for girls and boys has been awarded to Dr. and Mrs. Donald B. Armstrong, of Stapleton, N. Y. The paper will soon be issued by the company as one of the health and welfare series published for the benefit of its policyholders.

J. Warren Smith, head of the Columbus weather bureau for eighteen years and professor of meteorology at the Ohio State University, has been promoted to be chief of the division of agricultural meteorology with headquarters in Washington.

George W. Simons, Jr., assistant to the head of the Sanitary Engineering Department of Harvard Medical School and Massachusetts Institute of Technology, has been appointed chief sanitary engineer to the State Board of Health of Florida, and will take up his new work on July 1.

"Lassen Peak, our Most Active Volcano," is the title of a lecture recently given by J. S. Diller, of the United States Geological Survey, at Hunter College and before the Physi-

ographers' Club at Columbia University in New York, and the geological department of Lehigh University, South Bethlehem, Pa.

ON the occasion of the initiation ceremonies of the Yale Chapter of the Society of the Sigma Xi, on March 18, Professor J. McKeen Cattell, of Columbia University, gave the address, his subject being "Scientific Research as a Profession."

PROFESSOR S. A. MITCHELL, director of the Leander McCormick Observatory of the University of Virginia, delivered a lecture in Ottawa on March 22 before the Royal Astronomical Society of Canada on the subject "The Exact Distances of the Stars."

PROFESSOR FRANCIS G. BENEDICT, of the Nutrition Laboratory in Boston, lectured, March 14, at Wellesley College on "Living Without Food for Thirty-one Days. A Study in Prolonged Fasting."

MR. FRANK C. BAKER, zoological investigator of the New York State College of Forestry, at Syracuse, addressed, on February 25, the Syracuse Chapter of Sigma Xi on the "Relation of Molluscs to Fish in Oneida Lake."

PROFESSOR M. WEINBERG, of the Pasteur Institute, Paris, delivered a lecture on bacteriological and experimental researches on gas gangrene, with epidiascope demonstration, before the Royal Society of Medicine, London, on March 10.

PROFESSORS MARAGLIANO, of Genoa, and Rummo, of Naples, vice-presidents of the Italian Society of Internal Medicine, have issued an appeal for funds for the erection of a statue of the late Professor Baccelli to be placed in the Policlinico at Rome, in the foundation of which Baccelli took a leading part.

THE Elisha Mitchell Scientific Society held in the chemistry hall of the University of North Carolina on March 14, a memorial meeting in honor of Joseph Austin Holmes, late chief of the Bureau of Mines. The speakers were: Dr. F. P. Venable, Dr. J. H. Pratt and Dr. K. P. Battle.

ERASMUS DARWIN LEAVITT, of Cambridge, Mass., an engineer who made a specialty of pumping and mining machinery, past president of the American Society of Mechanical Engineers, died on March 11, aged eighty years.

ELTON FULMER, Washington state chemist and senior member and dean of the faculty of the Washington State College, Pullman, was killed in a railroad wreck at Cheney, Washington, on February 20, 1916.

MISS ADELE MARION FIELDE, known to scientific men for her work on ants, carried on at the Marine Biological Laboratory during a number of summers, died at Seattle on February 22, aged seventy-seven years. Miss Fielde was a missionary in Siam and China from 1866 to 1889, and is the author of several books concerned with Chinese conditions and Chinese folklore. She had been for many years active in movements for civic and social betterment.

THE death is announced, at Streatham, on February 18, of Professor R. H. Smith, formerly professor of engineering at the Imperial University, Tokio, and afterwards professor of civil, mechanical and electrical engineering at the Mason College, Birmingham.

DR. T. S. HALL, lecturer in biology in the University of Melbourne, and previously director of the School of Mines at Castlemaine, has died at the age of fifty-eight years.

DR. CHARLES GIRARD, professor of clinical surgery at the University of Geneva, Switzerland, has died in his sixty-seventh year.

DR. WALTER LOEB, head of the chemical department of the Rudolf Virchow Hospital in Berlin, died on February 7, aged forty-four years.

DR. WILHELM DEACHAES, curator of geology in the Hanover Museum, has been killed in the war.

ON April 1 the Illinois State Civil Service Commission will hold an examination for the position of geologic clerk in the office of the State Geological Survey. This position pays a starting salary of $75 a month with possi-

bility of later increase to $150. On May 6 an examination will be held for the position of assistant geologist. This position under the State Geological Survey pays a starting salary of $75 a month with possibility of increase to $120. The positions are open to persons over 21 years, including non-residents of Illinois. These examinations are unassembled. Questions relating to training and experience will be mailed to the applicants at their homes. The answers can be mailed to the commission, thus doing away with the necessity of non-residents coming to Illinois. If necessary, those who give satisfactory evidence of ability in this preliminary examination will be called together later for a personal interview at which final ratings will be assigned. For application blanks, address the Illinois State Civil Service Commission at Springfield, Illinois, or Room 904, 130 North Fifth Avenue, Chicago.

The New York State Civil Service Commission announces an examination on April 8 for zoologist in the State Museum, State Education Department, at a salary of $1,200. Candidates (men only) must have a general knowledge of biology, special training in zoology and a particular acquaintance with the animal life of New York state. They should also have a particular knowledge of the best methods of museum display, with ability to supervise work in taxidermy. Special credit will be given to those who have had actual experience in museum work and who have superior educational qualifications. There will at the same time be held an examination for examiner in the Educational Department, open to men and women. These examinations are held to provide eligible lists for permanent appointments at salaries of $900 to $1,500, and also to provide for a considerable number of temporary examiners required during the summer months at salaries from $75 to $125 a month. In all groups except commercial subjects and drawing, candidates must be graduates of a normal school or of an approved college and must have had three years' teaching experience in an approved secondary school in the subject or subjects in which they desire to be examined. No written examination will be given but candidates will be rated on education, training and experience as determined from the sworn statements in their application blanks and from responses to such inquiries as the commission may deem advisable to make. An oral examination may also be held. In filling out application blanks, candidates are requested in answer to question 20 to make full statement regarding experience. Applications will now be accepted for nine groups, including mathematics, physical science and biological science.

The agricultural department of the University of Minnesota is taking the lead in a movement to establish a national honorary society for agricultural students similar to Phi Beta Kappa and Sigma Xi. The plans for such a society have been formulated by a committee of faculty members of the college of agriculture, Professor A. V. Storm being chairman of the committee. Correspondence with other agricultural colleges is being conducted and it is hoped that such a society may be organized some time during the present college year. The standards of the new society will be high and membership will be based entirely upon scholarship in agriculture. The present plan is to take in senior students of the college of agriculture, graduate students in agriculture, and men who are doing practical work of unusual value in the field of practical agriculture. The movement started about a year ago with a group of agricultural students.

Corrosion of metallic structures is one of the most serious problems of modern engineering. It still awaits its solution. While it is a chemical phenomenon, electrical engineers are vitally interested in it, on account of the trouble of corrosion of underground structures often attributed to the stray currents from tramways. For the solution of the problem, electrical engineers and electrochemists must combine. For this reason the New York section of the American Electrochemical Society has accepted an invitation of the American Institute of Electrical Engineers to

hold a joint meeting on Friday evening, March 10, at the Engineering Societies Building, 29 West 39th Street, on the subject of corrosion. The principal speakers will be Dr. Burton McCollum, Bureau of Standards, Washington, D. C., for the American Institute of Electrical Engineers and Professor William H. Walker, Massachusetts Institute of Technology, Boston, Mass., for the American Electrochemical Society.

UNIVERSITY AND EDUCATIONAL NEWS

THE $1,800,000 of "University Building Bonds" voted by the people of California through approval of an initiative measure proposed by the alumni of the University of California, for additional building work on the campus at Berkeley, have been segregated by the regents of the university as follows: Benjamin Ide Wheeler Hall, a classroom building with a capacity of 3,500 students, its exterior to be of white granite, $700,000; completion of the university library, of which the present portion was built at a cost of $840,000, mostly defrayed by the bequest of Charles F. Doe, $525,000; second unit of the group of agricultural buildings, $350,000; first unit of a group of permanent buildings for chemistry, $160,000; new unit for the heating and power plant, $70,000; furnishings and equipment for the four structures first mentioned, $134,000.

THE contract for the new $60,000 chemistry building for Throop College of Technology was signed March 8, and the construction work was begun at once, the contract calling for the completion of the building in six months, which will be in time for the opening of the fall semester of 1916. This building is of reinforced concrete and hollow tile construction, and will consist of two stories and basement, and contain the research laboratories of Dr. Arthur A. Noyes, who will spend half of each year at Throop College, commencing next winter. The following appointments in the chemistry department for next year have recently been made, William N. Lacey, Ph.D., University of California, instructor in inorganic and industrial chemistry; Mr. James H. Ellis, of the University of Chicago and Massachusetts Institute of Technology, as research associate in physical chemistry, and Ludwig Rosenstein, Ph.D., of the University of California, who will become professor in inorganic chemistry.

THE Committee on Agriculture of the Massachusetts legislature has the full appropriation of $382,000 asked for new buildings this year by the Massachusetts Agricultural College.

MESSRS. COOLIDGE AND SHATTUCK, Boston, have been retained as architects for the new buildings of Lakeside Hospital and the medical school of Western Reserve University, and Mr. Abram Garfield, of Cleveland, for the new Babies' Hospital.

DISCUSSION AND CORRESPONDENCE

MESOZOIC PATHOLOGY AND BACTERIOLOGY

PALEONTOLOGISTS have not yet fully realized the possible value of geological evidences of disease to students of medicine. This may be due to the recent development of pathology and bacteriology or it may be due to the fact that the paleontology of the fossil vertebrates, especially, is still in a formative state. It is a fact, however, that paleontologists occasionally see objects from the early geological strata which show evidences of pathological or bacteriological activity. It would be of great value to those interested in medical subjects to have these objects discussed, since it would be of undoubted value to an understanding of the origin of disease.

Few attempts, so far as I am aware, have been made to bring to the attention of pathologists the earliest evidences of the occurrence of disease, although in the literature of paleontology one often finds figures of fossil bones showing "exostosial growths." Broken ribs, fractured limb bones, and injured vertebræ, a part or all of which show evidences of pathogenic conditions, are not uncommon. I wish in this place to plead for the proper discussion

of these objects, for in this way we may widen the scope and usefulness of paleontology.

The most notable advance, so far as I am aware, which has been made in this direction, is the work of B. Renault, who, in his large work "Microorganismes des combustibles fossiles"[1] has described and figured the bacteria, fungi and other pathogenic forms in the coprolites of fishes and in the coal of the Autun basin. I wish here to call attention to this really epoch-making work, with the thought that there might be others like myself, who were not aware of the existence of this important memoir. I am indebted to Mr. David White for calling my attention to this work and for loaning the volumes containing the memoir. The work is illustrated by 20 folio plates of untouched photomicrographs of bacteria, fungi, etc., and so conclusive is the evidence found there that no one can doubt Renault's conclusions. It is to the coprolites, or fossil feces, that the medical man would turn for evidences of disease and our author has figured and described in coprolites from the fishes of the Autun formations, many interesting colonies of bacteria, fungus growths, cultures of bacilli, organisms analogous to those producing caries of the teeth and many other important features of Mesozoic bacteriology. Some photomicrographs of fossil bone, obtained from the coprolites, showing the ravages of bacteria in the canaliculi, and bone corpuscles, are especially interesting.

So far as Mesozoic pathology is concerned the writer will describe and figure elsewhere a pathological growth involving two caudal vertebræ of a sauropodous dinosaur from the Como Beds of Wyoming. The original specimen belongs to the University of Kansas and I am indebted to Mr. H. T. Martin for the privilege of studying it. The growth looks remarkably like recent bone growths due to chronic osteomyelitis, or a bone tumor, or a callous growth possibly due to a fracture of the tail.

[1] *Bulletin de la Société de l'Industrie minérale Saint-Etienne*, Série III., 1899, Tome 13, pp. 865–1,161; 14 (1–2), pp. 5–159, 1900, with Atlas 1898–99, Pl. X.–XXV.; Atlas 1900–01, Pl. I.–V.

Williston[2] has figured the bones of the arm of a mosasaur showing pathological growth and synostosis of the carpals, possibly due to some infection. In the museum of the University of Kansas there is a mosasaur paddle showing extensive synostoses due either to disease or fracture.

It is interesting to note the possibilities open to paleontologists for the study of fossil remains. It is too early to say that a new field of research is opened up which will yield important results, but certainly such discoveries as may be made in this field of study will be of the greatest interest to those who are studying the activity and nature of modern diseases.

Roy L. Moodie

University of Illinois,
Department of Anatomy,
Chicago, Ill.

Efficient Summer Vacations

The late Mr. Taylor, efficiency expert extraordinary, once suggested that the pupils of technical schools be required to spend at least one year in commercial shop employment before they graduated. The opening, by Professor Riesman,[1] of the question of what to do with the summer vacation makes this an opportune time to suggest that the idea of compulsory practical experience is too good a one to go by default. But, three periods of three months each, in different plants and in positions of responsibility increasing with the growth of the student, seem to have many superior advantages and I venture to suggest the university control of its students during the summer period and a cooperation between educational and industrial institutions that shall furnish each student with a summer's work complementing that of the school year.

It should be as impossible as it is unnecessary for any student enrolled in a technical or scientific school to waste three months each summer. The graduates who go to work "in the South and Mid-Atlantic region" will not be excused by their employers from work during the summer because it is "out of the

[2] Geol. Surv. Kansas, Vol. IV., Plate LVI., Figs. 3 and 5, 1898.

[1] Science, February 25, 1916, p. 277.

question." Without detracting from the ultimate desirability of some such scheme as that proposed by Professor Riesman, may it not be more easy and advisable for us at once to adopt the principle of planning for the effective use of the summer vacation by all students in our technical schools, and of making three such periods a prerequisite for graduation? Our students will not be deprived of any more life, liberty and the pursuit of happiness than they will have to relinquish when they do graduate if we give them two vacation periods of approximately two weeks each, one immediately following the end of the school year, the other immediately preceding the next.

The chief objection to this scheme will come from those who want the summer for play—a class for whom we are not planning our college work—and those teachers who will claim that it is impossible to place the men. "Why?" "Oh, because industry doesn't want them." "Well then, train men who will be in demand; our best equipped institutions meet with little difficulty."

The scheme outlined has the merit of being the ideal toward which many of our institutions are even now striving, but complete success demands the wholeheartedness of combined effort and determination.

LANCASTER D. BURLING
GEOLOGICAL SURVEY OF CANADA

GERMAN GEOLOGISTS AND THE WAR

TO THE EDITOR OF SCIENCE: Some idea of the terrible way in which the war is depleting the ranks of German men of science can be gained from a study of the lists of German and Austrian geographers and geologists enrolled in military organizations which have been published in the "Geologische Rundschau." These lists, which can be found in the numbers published on December 8, 1914, February 26, 1914 and December 14, 1915, combined with a short list in the November, 1915, number of *Der Geologe*, contain a total of 237 names. Of this total, 54 are reported killed and two missing and probably dead, a mortality of almost twenty-five per cent.

The number of the *Geologische Rundschau* just received (published on December 14, 1915), contains portraits and obituaries of three young German geologists who are well known to many of the profession in this country through their participation in the excursions and meetings of the Twelfth International Geological Congress held in Canada in the summer of 1913. They are Curt Alfons Haniel, privatdozent in geology and paleontology in the University of Bonn, killed in action near Laon on December 29, 1914; Siegfried Martius, assistant in the Mineralogical-Petrographical Institute at Bonn, fatally wounded at Ypres on October 23, 1914; and Adolf A. Riedel, a student just completing the work for his doctorate at Munich, a man of unusually attractive personality and of great intellectual promise, who was killed in northern France on November 21, 1914. Another participant in the International Congress, Dr. Wilhelm Paulcke, of Karlsruhe, has been reported wounded and the recipient of the Iron Cross.

A further indication of the serious character of the German losses is given by the statement of the last number of *Der Geologe* (November, 1915) that 75 of the personnel of the Royal Prussian Department of Mines had lost their lives up to April 1, 1915. This periodical also reports that Dr. Quitzow, editor of *Der Geologe* and *Der Geologen-Kalender* had not been heard from for a year, after being in action on the eastern front.

WALTER L. BARROWS
TRINITY COLLEGE,
March 14, 1916

SCIENTIFIC BOOKS

The Feebly Inhibited: Nomadism, or the Wandering Impulse, with Special Reference to Heredity: Inheritance of Temperament. BY CHARLES B. DAVENPORT.

The author argues that "all cases of nomadism can be ascribed to one fundamental cause —that those who show the trait belong to the nomadic race" made up of those possessed of the nomadic impulse. This impulse "depends upon the absence of a simple sex-linked gene that 'determines' domesticity." The data for the argument are family-histor-

ies, reported in the main by field-workers. Each individual is rated (by the author apparently) as nomadic or non-nomadic. From this point on, the argument concerns the explanation of apparent exceptions to expectation by the hypothesis, and of numerical divergences from the ratios expected by the hypothesis.

It seems to the reviewer that the technique of this and similar studies might easily be very much improved by having the individuals who are to be classified (for nomadism or neuroticism or intelligence, or whatever the quality may be), rated quantitatively and independently by, say, half a dozen competent persons. Where, as here, records of persons, not the persons themselves, are to be rated, this means of reducing errors in the rating is very easy to apply. Its importance consists in the fact that at least ninety-five per cent. of the mental traits which have been measured objectively show no signs of a multi-modal distribution; and that consequently the *a priori* chances are at least 19 to 1 that the strength of the nomadic impulse varies from a single mode at moderate amount up toward extreme nomadism and down toward extreme domesticity. To begin work by classifying men on the supposition that the strength of the nomadic impulse is distributed with one mode of nomads and one mode of home lovers seems therefore peculiarly unwise. If we can not have objective measurements we can at least use the average of a number of subjective ratings and have these made by a scale detailed enough to measure the nomadic impulse as probably stronger in a man who "is a wanderer and has left home repeatedly and been away for months at a time . . . does not like to stay in one place long; likes to bum and tramp around" than in one of whom nothing more nomadic is recorded than that he was "a stage-driver."

With respect to the inheritance of temperament, the hypothesis defended is that "There is in the germplasm a factor, E, which induces the more or less periodic occurrence of an excited condition (or an exceptionally strong reactibility to exciting presentations) and its absence, e, which results in an absence of extreme excitability. There are also the factor C, which makes for normal cheerfulness of mood, and its absence, c, which permits a more or less periodic depression. Moreover, these factors behave as though in different chromosomes, so that they are inherited independently of each other and may occur in any combination."

The author classifies individuals by their zygotic formulæ as choleric-cheerful, choleric-phlegmatic, choleric-melancholic, nervous-cheerful, nervous-phlegmatic, nervous-melancholic, calm-cheerful, calm-phlegmatic, calm-melancholic.

He assumes further that "there is typically a difference in the mood of a person with two doses or only one dose of a determiner; that two doses of the E factor produce the choleric temperament, while only one dose results in the nervous temperament; that two doses of the C factor result in a normal, cheerful state, while if only one dose is present the individual has a tendency to appear phlegmatic, and if C is wholly absent, to appear melancholic."

The argument concerns, of course, the closeness of the fit of the ratios found to those expected and the explanation of the apparently unconformable cases.

The difficulty of classification may be appreciated by the reader who will try to assign each of these cases to some one of the nine classes, have scientific friends do likewise and compare the results with Davenport's assignments.

1. Subject to sprees; suicided with poison.
2. Had acute mania; violent and destructive.
3. Sx.;[1] restless and twitches.
4. Surly and disagreeable; was hypererotic and brutal to wife and children.
5. Has a swaggering air and manner; ran away from home; put in a reform school for rape.
6. Wild and hot-tempered; profane and ugly towards his wife; takes whisky regularly to forget his business worries.
7. Jailed at 14 years for rape; hung himself.
8. Rough and uncouth; easily excited, passionate; has fits of temper.

[1] Sx. means unduly sexual.

9. Was Sx.; attempted to hang herself; flew into fits of temper; was slovenly, seclusive, indecent; at 32 had delusions of being poisoned; threw herself out of window.

10. Cut his throat with a razor.

11. Cut his throat as his father did.

12. Garrulous; jumps from one topic to another; has sudden emotional changes; said to have attempted suicide.

13. Had a nervous breakdown twice; is very hot-tempered; jumps from one topic to another.

14. An actress who is obstinate, irritable and passionate; after childbirth she became deranged and is now obstinate, silly and shameless; has attempted suicide.

15. A great talker; at 31 became violent, restless, noisy; developed delusions and hallucinations and threatened to commit suicide.

16. Contrary and stubborn; hyper-religious; became noisy, restless, sullen, had delusions.

17. Impulsive, irritable and passionate; became excited; attempted to shoot himself.

18. Quick-tempered; at 32 became excited; had acute mania.

19. Alcoholic, cross, irritable; at 37 threatened suicide; was excitable; had delusions and hallucinations.

20. Quick-tempered, had delirium tremens and hallucinations.

21. Sulky and impatient as a boy; drank; quick-tempered, homicidal and suicidal; has hallucinations and delusions.

22. High-tempered, extravagant; became insane and jumped out of window, killing herself.

23. At 20 became erratic, silly, irresponsible; wanted to travel and follow girls.

24. Obstinate, irritable and passionate as a child; became hysterical and tried to hang herself and kill her child.

These are a random half of his cases of the choleric-cheerful.

Is it not wise to delay acceptance of any simple Mendelian hypotheses for the inheritance of the strength of the tendencies to wander, to be excited, calm, elated and depressed, until the pedigree individuals are measured, or at least classified, by some criteria that are objectively definable? The reviewer welcomes the studies of the Eugenics Laboratory and appreciates the devotion that inspires them and the labor which sustains them. But he is left unconverted by each one —indeed, more confirmed in the faith, or fear, that human mental traits are due to a number of determiners or a variation in strength of the same determiner.

EDWARD L. THORNDIKE
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A Comparison of Methods for Determining the Respiratory Exchange of Man. By THORNE M. CARPENTER. 265 pp.

Energy Transformations during Horizontal Walking. By FRANCIS G. BENEDICT and HANS MURSCHHAUSER. 100 pp.

Physiology of the New-Born Infant. Character and Amount of the Katabolism. By FRANCIS G. BENEDICT and FRITZ B. TALBOT. 126 pp. Publications Nos. 216, 231, 233. Carnegie Institution of Washington, Nutrition Laboratory.

The study of the respiratory exchange of man has long been, and will doubtless long continue to be, one of the most fruitful fields of physiological investigation. Its value rests chiefly upon this fact of supreme importance: namely, that alike during rest and exercise, in health and disease, the method of indirect calorimetry as calculated from the respiratory exchange affords measurements of the energy expenditures of the body which are in close agreement with direct calorimetric determinations. Not only are the technical procedures of the indirect method far simpler and more generally applicable than are those of the direct method, but the former also afford a deeper insight into the sources of the energy than do the latter. Thus from a measurement of the volume of the air expired in a given time, and an analysis of its content of oxygen and carbon dioxide, we can determine accurately the amount and the character of the food stuffs consumed in the body. From such data are to be deduced the dietetic needs of the clerk and the stevedore, the bread cards of a blockaded people, the ration of the marching soldier, the food needed by the new-born infant, and the requirements of the typhoid patient. With such data we may meet more

effectively "the high cost of living." It is altogether probable also that during the next few years determinations of the respiratory exchange will be extensively introduced into routine clinical use.

For these reasons there is a special timeliness in the thorough study of the principal methods now in use for the determination of the respiratory exchange in man, offered by Carpenter in the first of the publications above listed.

In general such methods fall into two classes: those involving a closed circuit on the Regnault-Reiset plan, and those involving a so-called open circulation. As the most complete working out of the closed circuit method the apparatus devised by Benedict has been especially studied in its various forms in the work before us. With the results so obtained Carpenter has compared particularly as examples of the open circulation the Zuntz-Geppert method and the method of Tissot, of which that of Douglas is a modification.

In all forms of the Benedict apparatus the subject continually rebreathes from a closed system of chambers, pipes and absorbers in which the air is kept in circulation by a blower. The total carbon dioxide exhaled is absorbed and weighed; and the total amount of oxygen required to replace that absorbed by the subject from the system is determined either by weight or volume.

In the Zuntz-Geppert method the subject inspires the outside air through valves and a mouthpiece, and expires through a meter connected with a sampling device. From the meter reading and the analysis of the samples the total oxygen absorbed and carbon dioxide exhaled are calculated.

In the Tissot method the subject also inspires outside air, but expires into a carefully counterbalanced and graduated spirometer, from which a sample is later taken and analyzed.

In the Douglas method the expired air is caught in a bag from which it is later forced through a meter: the respiratory exchange being determined by the meter reading and the analysis of a sample.

Carpenter finds that with care and skill practically equivalent results are obtainable with the Benedict, Zuntz-Geppert, and Tissot methods. With the Douglas bag the discrepancies are slightly greater, although in this case also inconsiderable.

Although Carpenter reaches no positive conclusion as to the superiority of the features of any one of the general methods above described, he does point out that the ability of the investigator to perform accurate gas analyses is of special importance; and that apart from the gas analyses the Benedict method is more complicated than the Zuntz-Geppert, Tissot or Douglas methods. He especially emphasizes the fact that for purposes of gas analysis the apparatus of Haldane is by far the most perfect yet devised. He makes the excellent suggestion that as a check upon the accuracy of the experimental data analyses of pure air also should always be made and reported.

The reviewer leaves this work with a strong impression, although perhaps Carpenter himself would disclaim any intention of creating it, that the best method now available consists in the use of a spirometer of the Tissot type (or for special purposes a Douglas bag) and a Haldane analyzer. Great as have been the contributions of the Benedict apparatus, it appears inferior to this form of the open circuit, alike in theory, in the complexity of its manipulation, and in the cost of installation.

In "Energy Transformations during Horizontal Walking" Benedict and Murschauser describe the results obtained from a man walking upon a treadmill driven at various rates of speed. The energy expenditure of the subject in a post-digestive condition, standing absolutely still, is first determined. By subtracting this basal value from the figures obtained during walking they compute the extra energy expended in moving the body per kilogram and horizontal meter. For slow paces a distinctly uniform figure is obtained. This increases, however, with rapid walking, a point being reached at which the energy expenditure of running is less than that of rapid walking. It is shown that the high rate of energy ex-

penditure during rapid walking is largely due to the swinging of the arms. In running they find that a great part of the energy is consumed in the up-and-down motion of the body. They point out that the elimination of these factors is the line along which economy of energy is to be obtained.

In the "Physiology of the New-Born Infant" Benedict and Talbot include a translation of an important paper by Hasselbalch hitherto not generally accessible. Hasselbalch concludes that a well-nourished infant born at full term has a store of carbohydrates upon which it draws during the first few hours of life with a respiratory quotient well up toward unity. Thereafter for a time the respiratory quotient is lower and the metabolism approaches a fasting character. These striking results are not fully confirmed by Benedict and Talbot. Although in some cases they also find a decidedly high respiratory quotient, they suggest that it is due to an excessive blowing off of carbon dioxide during crying. They demonstrate the relatively great amount of energy which an infant expends in this exercise, and point out that even under normal conditions the mother never supplies sufficient nutriment to balance the infant's output during the first few days after birth. They emphasize the importance of keeping the newborn infant from crying, and so far as possible from any muscular exertion, in order to conserve its initial store of energy.

In the introduction to this work the authors complain of "a disposition on the part of some investigators to relieve us of the responsibility of interpreting certain of our results." The reviewer has not ascertained who these culprits are, or the extent of their fault. He is inclined to offer as a defense for them, however, that the one defect of the splendid publications which come from the Carnegie Nutrition Laboratory is that they are confined in most cases too largely to a statement of the methods and experimental results, without summaries or even emphatic textual indications of the opinions which the investigators themselves have reached. Most authors who write thus receive the just punishment of being unread. It is only for work of the highest order that the sentence is commuted to mere misinterpretation.

YANDELL HENDERSON
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An Introduction to Neurology. By CHARLES JUDSON HERRICK. Philadelphia, The W. B. Saunders Company, 1915. Pp. 355, 137 figs.

This work is an example of marked success in the accomplishment of a difficult task. In dealing with such a subject as the nervous system it is probably easier to write a small book or a very large one than to produce a valuable one of medium size. One can write a short account of the mechanism, shirking the intricacies of its structure, and emphasizing what is picturesque and entertaining. Or, by taking more time, one can prepare a voluminous and impersonal account of it which shall serve for reference rather than consecutive reading. To write a book which shall be quite minute as to detail and yet concise and readable is a severer test of a man's scholarship and power.

The book in hand meets the requirement. The material is arranged with unusual skill and the presentation is masterly. The distinction is less in the freshness of the facts than in the selection made and the clarity of exposition displayed. Without indulging in digression or sacrificing accuracy the author has given his work a literary quality which is refreshing. There is a geniality about it all which to an exceptional degree establishes a rapport between writer and reader.

Without offering any objection to the author's choice of terms it may be in order to express regret that biologists can not agree upon the significance of the "sympathetic system." Professor Herrick makes it as inclusive as possible, that is to say, equivalent to the autonomic system of Langley. It seems clear that physiologists generally hold to the other conception, making the sympathetic the thoracico-lumbar autonomic. We commonly say that the heart is inhibited by the vagus and accelerated by the sympathetic fibers, yet

the vagus belongs to the sympathetic in the broader sense.

The figures used in the book are largely new and in all cases well adapted to illustrate the descriptions in the text. P. G. Stiles

SPECIAL ARTICLES

THE BOTANICAL IDENTITY OF LIGNUM NEPHRITICUM

The attention of the writer has just been called to the following criticism of his recent preliminary paper on *lignum nephriticum*, which appeared in *Nature*, Vol. 96, page 93, 1915.

> The most recent contribution to the history of *lignum nephriticum* is published in the *Journal of the Washington Academy of Sciences* (Vol. V., No. 14, August 19, 1915) by Mr. W. E. Safford. He gives the name *Eysenhardtia polystachya* (Ortega) Sargent, to the tree, and states that its botanical identity has remained uncertain until the present time. This statement, however, is scarcely correct, since the tree was referred to the genus *Viborquia* by Ortega, a name superseded by the later name of *Eysenhardtia* of Humboldt, Bonpland and Kunth. These authors correctly named the plant *E. amorphoides* in 1823, and Mr. Safford, following Sargent, merely restores Ortega's old specific name, *Viborquia polystachya*, making *Eysenhardtia amorphoides* a synonym of *E. polystachya*.

The above criticism is quite misleading. It is true that the species in question was described by Ortega in 1798; but Ortega drew his description from a shrub growing in the Royal Botanical Garden of Madrid, which had been propagated from seed sent to the garden from Mexico. He had no idea that the plant he described had any connection with the classic *lignum nephriticum;* he did not know its Mexican name; indeed he was unaware that it might attain the dimensions of a tree. Humboldt, Bonpland and Kunth were likewise unaware that the plant described by Kunth as *Eysenhardtia amorphoides* was the source of *lignum nephriticum*, or that its wood would yield a fluorescent infusion. That its identity with the latter was unknown is shown by the definite statement of Sargent, when establishing the combination *Eysenhardtia polystachya*. Referring to *Eysenhardtia* he says:

> The wood of some species is hard and close-grained and affords valuable fuel. The genus is not known to possess other useful properties.[1]

If the species described first by Ortega as *Viborquia polystachya* and later by Kunth as *Eysenhardtia amorphoides* was known to be the source of *lignum nephriticum*, a classic wood remarkable for the fluorescence of its infusion and at one time famous throughout Europe, why would not these authors have called attention to its identity?

The first to indicate its botanical identity, as the writer pointed out in his paper cited above, was Dr. Leonardo Oliva, professor of pharmacology in the University of Guadalajara (1854), but his identification was not accepted by subsequent authorities. Oliver and Hanbury, in the "Admiralty Manual of Scientific Inquiry" (page 391, 1871), call attention to the wood as follows:

> *Lignum nephriticum.*—This rare wood, noticed by some of the earliest explorers of America, is a production of Mexico. To what tree is it to be referred? Its infusion is remarkable for having the blue tint seen in a solution of quinine.

In the third edition of the "Nueva Farmacopea Mexicana" (page 153, 1896) the statement is made that *leño nefritico* had been erroneously attributed to *Varennea polystachya*, or *Eysenhardtia amorphoides* H. B. K., but that its classification was not known. Dragendorf in his well-known Heilpflanzen (page 345, 1898) refers it to the genus Guajacum:

> Das Lignum nephriticum der älteren Medicin wird wohl von einer Guajacum-Art stammen.

Dr. Otto Stapf, to whose historical paper on *lignum nephriticum* published in the "Kew Bulletin of Miscellaneous Information" (pages 293–305, 1909) the writer has already referred, experimented with a piece of wood from the Mexican collection in the Paris Exposition, bearing the label "Cuatl." Dr. Stapf referred this wood to *Eysenhardtia*

[1] Sargent, C. S., "The Silva of North America," Vol. 3, p. 30, 1892.

amorphoides, but his specimen was not accompanied by botanical material which would serve to establish its identity with certainty, and a later investigator, Dr. Hans-Jacob Möller, of Copenhagen, who also made an exhaustive study of the wood from historical and pharmacological standpoints, failing to find fluorescence in specimens of *Eysenhardtia* wood sent to him from Mexico ("das Kernholz von einem recht dicken Ast," which yielded "keine Fluoreszenz") arrived at the conclusion that the mother-plant of *lignum nephriticum* must be a Mexican species of *Pterocarpus.*[2]

The conflicting conclusions of Dr. Stapf and Dr. Möller, assigning *lignum nephriticum* to mother-plants of two distinct genera, caused the writer to continue his researches as to the origin of this classic wood, the botanical identity of which he had been seeking to establish for more than twenty years. Specimens of wood accompanied by botanical material sufficient to identify it with *Eysenhardtia polystachya* came into his possession in 1914 and led to the publication of his paper "*Eysenhardtia polystachya,* the source of the true *lignum nephriticum Mexicanum,*" in the *Journal of the Washington Academy of Sciences,* in August, 1915. Certain discrepancies, however, in the early accounts of *lignum nephriticum* caused him to pursue his investigations still farther.

Dr. Stapf assumed that the *Palum Indianum* of which Johannes Bauhin's cup was made, "almost a span in diameter and of unusual beauty," with chips of the same wood of a reddish color, and the "white" wood yielding an infusion like pure colorless spring water, of which Athanasius Kircher's cup was made were both identical with the dark-colored wood used by Robert Boyle in his historical study of fluorescence. A further source of confusion was Hernandez's account of the logs of *lignum nephriticum* carried to Spain, specimens of which he declares he has seen "larger than very large trees." Bauhin's figure of his wood does not in the least suggest the wood of *Eysenhardtia polystachya,* but does resemble the wood of *Pterocarpus indicus* of the Philippine Islands.

We have an authentic account of the manufacture of cups from this Philippine wood and of their medicinal use, exactly as described by Bauhin and Kircher, written by Father Delgado, who, when a boy in Cadiz, was given fluorescent water to drink from one of them, as a remedy for a certain malady, and who afterwards saw the cups in southern Luzon. Delgado identifies the wood of which these cups were made as that of the Philippine *naga* or *narra* (*Pterocarpus indicus*), a tree of great dimensions, yielding logs of large size, many of which were undoubtedly carried to Spain by way of Mexico at a very early date. Of this wood there are two recognized varieties, one pale colored, locally designated as "female," the other of a reddish color, called "male" narra. From the first of these was evidently carved the cup described by Kircher; from the second the cup presented by Dr. Schopff, physician to the Duke of Würtemberg, to Bauhin.

Very distinct in texture and appearance from the wood of the Philippine *Pterocarpus indicus* is that of the Mexican *Eysenhardtia polystachya.* Moreover, the latter species never attains the size of a tree capable of yielding large logs. It must also be noted that there is no record of a single cup made of its wood. A search for such cups in Mexico has been futile, while cups made of *Pterocarpus indicus* were common in the Philippines at the time when Delgado wrote. They could only reach Spain by way of Mexico, and they might easily have been thought to be of Mexican origin. Delgado was a Jesuit and it was from the *Procurador* of the Jesuits in Mexico, that the Jesuit Kircher received the cup described by him.

A full account of the two woods known as *lignum nephriticum,* illustrated by colored plates, will appear in the Smithsonian Report for 1915.

W. E. SAFFORD
BUREAU OF PLANT INDUSTRY,
February 2, 1916

[2] *Berichte der deutschen Pharmaz. Gesellsch.,* Vol. 23, pp. 88–154, 1913.

PRELIMINARY STUDIES ON HEATED SOILS

A FAIRLY extensive amount of data has been accumulated upon the immediate changes induced in soils heated to temperatures between 50° C. and 500° C., with reference to the effect of such treatment upon seed germination and plant growth. The results appear to have some value in explaining the striking effects, injurious and beneficial, observed on sterilized or partially sterilized soils. The work of Russell[1] and his associates, Pickering[2] and Schreiner and Lathrop[3] have led in general to quite different conclusions as regards the nature of the injurious action. These and other workers have also maintained considerably different views regarding the nature of the beneficial action of sterilized soils. The difference in opinion is perhaps due in a large measure to the point of view from which the investigation has been undertaken, as well as to the manner in which the sterilization of the soil has been accomplished. The conclusions drawn here are considered to apply particularly to soils heated above 100° C., although it is believed that the same principles apply in soils heated to lower temperatures. An endeavor has been made to give due consideration to the several phases of the subject since these involve not only chemical, biological and physical changes in the soil, but also the physiological and pathological conditions of the seeds and plants grown in these soils.

The method of investigation by which the results presented in this paper were obtained has been largely that of attempting to correlate the chemical changes produced in the heated soils with their effect upon seed germination and plant growth. The amount of water-soluble material formed by heating has been measured by the lowering of the freezing point. For this the Beckmann thermometer was used. Ammonia was determined by the ordinary method of distilling in the presence of magnesium oxide. The nitrate was determined colorimetrically by the phenoldisulphonic acid method. Seed germination tests were made on the soil in Petri dishes. The seeds were placed on the surface of the soil, which was almost saturated with distilled water. Various kinds of seeds were employed, but especial use was made of cabbage.

The results in general were similar for the different seeds, though they varied much in their susceptibility to the injurious action. Lettuce and clover seeds, for instance, were very susceptible to the injurious action of highly heated soils, whereas rye and buckwheat were very resistant. Plant growth is affected in much the same manner, wheat, for example, recovering rapidly from the deleterious action of certain heated soils where tomatoes appeared to be permanently injured. Different soils give markedly different results upon heating to the same temperatures. The action appears to be dependent particularly upon the content of organic matter in the heated soil, as this influences both the amount of decomposition and the absorptive power of the soil for the substances produced upon heating. These results are in general confirmatory of the work of others upon this subject.

The temperature to which the soil is heated is seemingly the most important factor in determining the extent of the injurious or beneficial action. Approximately 250° C. was found to be the most critical temperature in all the soils used. At this temperature seed germination was most strikingly retarded. Early plant growth was usually checked for the longest period of time on soils heated to 250° C., although late plant growth, in the case of some crops at least, was most vigorous on these soils. Heating to temperatures of 300° C., or above, in all the soils used, again reduced the injurious action to seed germination and early plant growth, as well as the beneficial action to late plant growth.

Heating soils to 250° C. produced greater amounts of material extractable with water than heating to higher or lower temperatures. The ammonia content of the soil increased proportionally to the temperature of heating up to about 250° C., after which it rapidly

[1] Russell and Petherbridge, *Jour. Agr. Sci.*, 5: 248–287, 1913.

[2] Pickering, *Jour. Agr. Sci.*, 3: 277–284, 1910. Soils Bul. 89, pp. 7–37, 1912.

[3] Schreiner and Lathrop., U. S. Dept. Agr., Bur.

fell to a minimum. The increase in ammonia was accompanied by a decrease in nitrates, which were practically non-existent in the highly heated soils.

The ammonia produced on heating soil has been suggested by Russell as causing the injurious action, although no evidence on this point could be obtained. Pickering suggested that the injurious factor was volatile in nature, on account of its gradual disappearance from the soil, but Russell disagrees on this point. Russell, however, worked with low temperatures, usually not exceeding 100° C., and with volatile antiseptics. Under such treatment, only relatively small amounts of ammonia are produced directly, and seed germination and plant growth are not so strikingly affected as in soils heated to higher temperatures.

The percentage of seed germination has been found to be closely correlated with the amount of ammonia present in the heated soils studied. The amount of ammonia required to injure germination, however, appears to vary with the type of soil when comparisons of different heated soils are made. It appears that the absorptive power of the soil is a very important limiting factor in determining the extent of the injurious action.

The presenec of dihydroxystearic acid as described by Schreiner could not be demonstrated in the most toxic of the heated soils. That the toxic substance is of a volatile nature is evident by the fact that it is readily removed from the soil by aeration. If collected in water upon removal, its toxicity can be readily demonstrated. By collecting in a hydrochloric acid solution the chemical composition of the resultant salt has been shown to be ammonium chloride, containing ammonia in sufficient quantity to account for the toxic action of heated soils.

It is improbable that all the ammonia produced in heated soils exists as free ammonia. Large amounts of carbon dioxide are also produced when soils are heated, which possibly accounts for the increased acidity of heated soils. The evidence at hand points toward the formation and injurious action of ammonium carbonates particularly. These salts being unstable in the soil except when kept in a dry and unaerated condition, accounts for the gradual disappearance of the injurious action of heated soils. It also appears that other compounds of ammonia are formed which are more stable in character.

The beneficial action of heated soils on plant growth, especially of those heated between 150° C., and 250° C., is believed to be due in a large part to the direct assimilation of ammonia or ammonium compounds by the plants after the manner described by various workers. The increased growth follows in practically all cases after a period of injurious action to plant growth, and is no doubt dependent upon the reduction of the toxic substance to a point where it is stimulatory or acts as a plant food. The relative importance of increased plant food production as a result of bacterial activity, and of direct chemical action, in highly heated soils remains to be ascertained.

The writer will be pleased to obtain suggestions or criticisms on the point of view presented in this paper.

JAMES JOHNSON
UNIVERSITY OF WISCONSIN

NOTE ON THE INTERFERENCES OF PARALLEL AND CROSSED RAYS

AFTER perfecting the design (Fig. 1) of my last article[1] thus obtaining an apparatus which is free from transmission through glass and in which all the rays are guided by reflection from metal surfaces only, I have secured definite evidence showing that the strands of interference patterns obtained are actually referable to the intersection of two grids, due to the two sodium lines, respectively. One of the grids is retarded in rotational phase with respect to the other. Why in the case of a transmitting grating, the nature of the phenomenon is so effectively concealed, I have not been able to make out; but with mercury light, but one set of striations is obtained, as anticipated.

With this definite understanding of the phenomenon, the resolving power works out as

[1] SCIENCE, February 25, p. 282.

$$d\lambda/\lambda = D\, dh/R\sqrt{D^2 - \lambda^2}$$

where D is the grating space, R the path length and dh the displacement of the second grating G', normally to itself, between like rotational phases of the two sodium lines. The second member of the equation is roughly dh/R and if $dh. = .003$ cm. is still guaranteed and $R = 300$ cm. as in my apparatus, the limiting resolving power is $d\lambda/\lambda = 10^{-5}$ or .06 *A. U.* If $d\lambda/\lambda = 10^{-3}$ for the two sodium lines, $dh = .3$ cm., which is about what I found.

An interesting application of the apparatus (Fig. 1) or the other similar types may be suggested. By half silvering the mirrors and providing a similar set *beyond* them, there should be no difficulty of bringing the interferences due to crossed rays, and to parallel rays, into the field of the telescope, *together*. Strictly homogeneous light (mercury arc) would be needed to obviate the duplications of the sodium arc. In such a case, therefore, the parallel fringes could be used after the manner of a vernier on the crossed fringes. One might think of this with a view to a repetition of the experiment of Michelson and Morley, if this experiment had not been so thoroughly carried out by the original investigators. However, the plan would be to rotate the apparatus, as a whole, so that the two crossed rays would be alternately in and at right angles to the earth's motion, whereas the two parallel rays would preserve the same relation to that motion. Naturally the parallel and crossed paths would in such a case have to be enlarged by multiple reflection. Another favorable feature of the reversed spectrum interferometer is the small displacement, x, of micrometer per fringe. This is $x = \lambda/2(1 + \cos\theta)\cos\sigma/2$, θ being the second angle of diffraction, σ the sum of the two. Hence roughly $x = \lambda/4$, or the sensitiveness is about twice that of the customary types of apparatus.

Carl Barus

Brown University,
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SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The 107th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club, at 8 P.M., Tuesday, November 2, 1915. Forty-five members and six guests were present. The following papers were presented:

Relation of Catalase and Oxidases to Respiration in Plants (with lantern): Chas. O. Appleman. (To be published in full as bulletin number 191 of the Maryland Agricultural Experiment Station.)

The chemical mechanism of respiration in plants is very complex and imperfectly understood. Enzyme action undoubtedly plays the most important rôle. Among the enzymes which have been assigned various functions in respiration, we find the oxidases and catalase, although their relation to this process is almost entirely hypothetical. Respiration in potato tubers is not only greatly accelerated by various artificial treatments, but is subject to fluctuations under natural conditions, such as greening and sprouting. The rate of respiration also varies in different parts of the same tuber and tubers of different varieties. Since these tubers also contain very active catalase and oxidase, they were chosen as specially favorable material to make a quantitative study of the relation of both catalase and oxidase activity to the intensity of respiration. The data seem to justify the following conclusions:

1. The oxidase content in potato juice gives no indication of the intensity of respiration in the tubers. In other words, there is no correlation between oxidase activity and the rate of respiration in these organs. The author does not disclaim any rôle of the demonstrable oxidases in respiration, but they certainly are not the controlling factor in regulating the rate of respiration in potato tubers.

2. Catalase activity in the potato juice shows a very striking correlation with respiratory activity in the tubers.

Some Philippine Botanical Problems: E. D. Merrill.

To be published in full elsewhere.

Botanical Notes of a Trip to Japan: W. T. Swingle.

To be published in full elsewhere.

The 108th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club, at 8 P.M., Tuesday, December 7, 1915. Thirty-two members and three guests were present. Messrs. A. T. Speare, James Johnson, H. R. Rosen and H. C. Rose were elected

to membership. The following papers were presented:

Dr. W. Ralph Jones: An Appreciation: DR. C. L. SHEAR.

Dr. Jones was quiet and retired in disposition and of excellent habits. He had a great aversion to taking animal life and would not take courses in zoology involving the death of higher animals; neither would he hunt nor fish. His chief recreation and amusement were novel reading and music. He was very fond of reading good French novels in the original, and of the opera. He showed an interest in natural science early in life and as a boy began a collection of minerals and also an herbarium of flowering plants. His interests in botany were broad and his training in languages, chemistry, physiology, etc., were such as to give a broad and substantial foundation for research. He possessed three of the fundamental requirements for success in scientific work, that is, love for truth, combined with thoroughness and accuracy. His notes, drawings and manuscripts were models of neatness and accuracy. He had undertaken several lines of investigation in connection with blackberry, currant and gooseberry diseases, but had practically completed only one of these. This was a study of what appears to be a new species of *Thielavia* isolated from diseased dewberry plants. It is to be deeply regretted that a man so well equipped by temperament and training for research should be cut down in the prime of life and usefulness.

Experimental Study of the Life Duration of Seeds (with lantern): DR. WM. CROCKER.

To be published in full elsewhere.

Notes on Variations in Chinese Chestnuts (specimens): P. L. RICKER.

To be published in full elsewhere.

THE 109th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., Friday, January 14, 1916. Seventy members and five guests were present. Messrs. Rodney B. Harvey, G. McMillan Darrow and Roland McKee were elected to membership.

Economic-Botanical Exploration in China (with lantern): FRANK N. MEYER.

Mr. Meyer, an agricultural explorer of the United States Department of Agriculture, has spent nine years in China and adjoining countries studying the flora of this region and searching for plants of economic value for introduction into the United States. He found quite recently a hickory in China which has never been recorded in botanical literature. As yet no sycamores nor any papaw (*Asiminia triloba*) or leather-wood (*Dirca palustris*) have been found in China. Field work in botany in China is extremely difficult because most of the wild vegetation near densely settled parts has been exterminated. However, Buddhist and Tavist priests have preserved many specimens in their temple compounds. Mr. Meyer made reference to the discovery of the wild peach in the provinces of Shansi, Shensi and Kansu, and to the expertness of Chinese gardeners in grafting. He expressed the opinion that in this country there is great need of national arboreta and permanent botanical collections.

The Recent Outbreaks of White Pine Blister Rust: DR. PERLEY SPAULDING.

When this disease first reached this country, it was thought repeated annual inspections of the lots of diseased trees would soon result in the complete eradication of the disease. Our experience since that time, together with increasing knowledge of the characteristics of the disease, shows us that this is not true. Apparently the only method of completely eradicating this disease in any lot of infected trees is that of total destruction of that lot. While large numbers of plantings of diseased imported trees were made in 1909, the careful inspection work done since that time by the states has kept the disease in them almost completely in control. It has become increasingly evident that our great danger lies in lots of diseased trees which were imported before 1909. These in most cases we know nothing about and of course have not been able to give them the necessary inspection. In the years 1909 to 1914, inclusive, there were eleven outbreaks of this disease, that is, cases where it escaped from the diseased pines on to neighboring currants or gooseberries. In 1915 the weather conditions were so favorable for the disease that it spread very readily and for relatively long distances. Last year twelve outbreaks occurred. These areas vary in extent from only a few currant or gooseberry bushes up to a single area of some 400 or 500 square miles. Experiments have shown that the wild currants and gooseberries of the Pacific coast and Rocky Mountain regions are susceptible to it. In fact it may be stated that all species of currants and gooseberries, so far as they have now been tested, are susceptible. The ordinary cultivated black currant, *Ribes nigrum*, however, is far more susceptible than any other species. While it

is not grown in large quantities, it is very widely scattered; enough so that the disease during the past season readily spread upon this single species for miles. The future of the white pine, which has been quite largely depended upon for the forests of the northeastern states, is very seriously threatened by this disease, unless efficient efforts are made to control it. The character of this fungus is such that the removal of all wild and cultivated currants and gooseberries from the affected areas will stop its further spread in those areas. If the cultivated black currant could be eliminated from the nursery trade so that it would not be sold and its use could gradually be discontinued everywhere within the affected states, a great step would be taken toward the control of this disease. But more than this, state officers must have absolute power to destroy diseased pines and currants and gooseberry bushes, in order that unanimous action can be carried out within these affected areas. With this power should also be given the power to declare and enforce quarantines against shipments of stock from other states. When compared with minute search which is required in finding gypsy and brown-tail moth nests in southern New England, the search for wild and cultivated currants and gooseberries is comparatively simple. It also is comparatively easy to carry out when compared with the climbing of trees 75 to 100 feet in height in certain sections of New England for the removal of brown-tail moths' nests, as is done every year. An efficient fight against this disease even now is not impossible, but it very shortly will be if not started at once.

Catha edulis: A Narcotic of the Southern Arabs (with specimens): Paul Popenoe.

The kat, Arabic *qat*, shrub is a native of Africa, but much cultivated in Yaman, where its use is increasing so that the town of Aden now consumes annually more than 2,000 camel-loads of the leaves and twigs, which are chewed for their stimulating properties. The plant contains small quantities of an alkaloid called *katrine*, which seems to resemble cocain. It has been introduced into the United States by the Office of Foreign Seed and Plant Introduction, United States Department of Agriculture, and grows well in the South. The dangers from its use have probably been much exaggerated. This plant may present commercial possibilities as the source of a new beverage to compete with tea.

W. E. Safford,
Corresponding Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 550th regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, February 12, 1916, called to order at 8 P.M., by President Hay.

Fifty persons were present.

On recommendation of the council Walter P. Taylor, Museum of Vertebrate Zoology, Berkeley, California, was elected to active membership.

Under the heading Brief Notes and Exhibition of Specimens, Dr. Howard called attention to the work lately done by Dr. W. V. King, of the Bureau of Entomology, in demonstrating that *Anopheles punctipennis* was a carrier of both tertian and estivo-autumnal malaria parasites. He exhibited lantern slides of this mosquito and photo-micrographs of the stages of the malaria organism in this hitherto supposedly harmless species of mosquito.

Under this same heading W. L. McAtee gave some of his recent observations on the vegetation in Virginia in the region south of Washington.

The first paper of the regular program was by Henry Talbott: "Nepigon." Mr. Talbott gave an entertaining account of a trip made by himself and others to Lake Nepigon. The fishes of the lake and neighboring region were especially dwelt on. Mr. Talbott's paper was discussed by Dr. Howard.

The second and last paper of the regular program was by Vernon Bailey, "Game and Other Mammals of the Yellowstone Park Region." Mr. Bailey gave a short outline of his itinerary on a recent trip through the Yellowstone Park and the neighboring region, particularly to the south. The ground covered was mainly off the tourist track. The speaker described the beauties of the park from the viewpoint of the lover of wild life; he called particular attention to the loss of fear of men by wild life when protected from guns, dogs and cats; he called to notice the thriving condition of herds of ruminants in the park and the successful efforts now made to supply hay to the needy in winter, and to keep the antelope from wandering out of the park. Mr. Bailey's communication was profusely illustrated with lantern slide views of the park and its wild life, in especial, the white-tailed deer, mule deer, elk, moose (recently described as *Alces shirasi*), antelope, bison, some of the smaller mammals, and Canada geese.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SCIENTIFIC TRUTH AND THE SCIENTIFIC SPIRIT[1]

IN appearing before you this evening in my present rôle I can not but recall an incident of fifty-five years ago, which often recurs to my mind when I think of the events of to-day.

The trustees of the Smithsonian Institution in 1861 were preparing their programme for the year, and in this programme were courses of lectures to be given to the public on a series of selected topics. Their intention was announced and they were importuned to devote those lectures to what was at that time in everybody's mind. It was the first year of your great war of the Secession. I say your war, but I might, with some justification, have called it our war, for there fought in the ranks of the armies of the North 68,000 British citizens, of whom 45,000 were Canadians, and of the latter 15,000 lost their lives. There were even then stop-the-war people, prototypes of the Fords, the Akeds, the Jane Addamses and the Lloyd Joneses of to-day, futile, mole-visioned and cloister-minded, who imagined that the great conflict could be prevented by talking and they wished to avail themselves of the opportunity the lectures might present of showing how it could be done.

The trustees apparently wished to be neutral, perhaps they were uncertain what the upshot of the conflict was going to be, and this may have helped them to decide, as they did, that all war topics should be

[1] Address delivered at the annual dinner of the Columbia Biochemical Association, February 10, 1916.

excluded from their program. To secure that they invited Professor, afterwards Sir Daniel Wilson, of the University of Toronto, to give a course of lectures on "Prehistoric Man." Professor Wilson was eminent for his attainments and achievements in many fields, but he was chiefly known at the time as a pathmaker in what were then the trackless wilds of the earliest history of our race, and, therefore, the selection of him as a lecturer on the subject could not have been more aptly made. It was a fortunate selection from another point of view. His subject could not be remotely associated with the war then begun, but, had it been otherwise, his habit of mind prevented him from alluding to it in his lectures, and not even once in his conversation during his stay in Washington did he indicate the slightest interest in the great struggle. There were occasions when he could have referred to it. Frequently during the delivery of his lectures the boom of cannon heard in the lecture room—coming from across the Potomac—punctuated his sentences. According to the late Dr. Otis T. Mason, who was my informant on this subject, he left as a memory of his visit a reputation for mental detachment that was Olympic in its character.

This evening I appear before you in a rôle which is in some respects parallel to that filled by Sir Daniel Wilson on that occasion, but there are in it contrasts also. Your country, your nation is now at peace and it is my country that is at war, engaged in a struggle unparalleled in history. Canada has already played a part and she is preparing to play a larger one. She is to increase her army of 200,000 men to half a million, that is, to train and arm five men out of every twelve of the male population between the ages of eighteen and forty-five. That will indicate the magnitude of the task we have undertaken. There can be no mistaking the seriousness with which we regard what is before us. Our young men are preparing to do their duty and to pay the toll that may be exacted. Daily through my laboratory windows comes the sound of the drilling of more than seventeen hundred men, which goes on from morn to night on our university lawn. We have already sent seven hundred of our students and young graduates overseas on active service and we have now a continually lengthening roll of honor with its sad, yet noble, memories of those whom age shall not weary nor the years condemn. The end may be far off and the future is dark and heavy with fate, but we are going forward with the determination that, though life will never again be as it was in the joyous, carefree past, a new world shall come into being as a compensation for the sacrifices that we are making and are yet to make. We are certain above all things of one result, and it is that this war is forging on the anvil of destiny, in the fierce furnace heat of the conflict, the scattered, loosely-knit portions of our Anglo-Celtic empire into an organization, an instrument that shall be a guarantee of happiness and liberty to countless millions yet unborn.

It is the thought of all these things crowding in on my mind that prevents me from adopting the absolutely detached, Olympic mind that Sir Daniel Wilson displayed when your nation was being welded into one in the furnace heat of the great Civil War. I am not, however, going to allow these thoughts to crowd out those which it is my duty to express to you on this occasion. I must look forward, as you must also, to a time when the welter of baleful hatred and paleolithic fury of the

hour will be past, though not forgotten, to a time when men of science of all nationalities may, under better auspices, and in spite of the chauvinism that will be the result of this war, cultivate once more a camaraderie on the intellectual high road of life. And in looking forward we must strive to strengthen those forces which, out of all the wreckage of to-day, remain to assist us in restoring what we, two years ago, were wont to believe could never be swept away.

What are those forces? They are scientific truth and the scientific spirit, both of them intangible entities or principles, but for all that destined to play a part in the restoration of the world to sanity.

It is upon these that I am to dwell this evening, and I have chosen them as the subject of my address in the hope that, in holding your attention for the moment, I may direct your thoughts to questions which are of enduring interest to all workers in science.

To workers in biochemistry these topics are of fundamental importance because our attitude toward them, our comprehension of their significance, determine our usefulness as scientific investigators. As students of the phenomena of living matter we are constantly in touch with problems which, to many, seem inscrutable, inexplicable on the basis of our present knowledge. There is in the make-up of our personalities a tendency to classify the inexplicable as transcendental and to believe that in living matter there operate forces that can never be scrutinized and examined as we examine the forces of the ordinary physical world. That tendency of mind, from which I say few are wholly free, is, when unchecked, a negation of the scientific spirit, and to a mind more or less influenced by it there can be no scientific truth, for the latter is the product of the scientific spirit.

There may be some who will ask "What is truth?" They ask the question not in the spirit and intent of the procurator of Judea, but because they are perplexed by the irreconcilable interpretations of the term "truth" as advanced in the discussions amongst the different schools of philosophical thought. The perplexity is to a certain extent natural, but it ought not to prevent us from finding an answer to the question which will meet the tests, not only of daily life, but also of the world of science, as a brief consideration of the doctrines of two diametrically opposed schools of thought may show.

Amongst the adherents of one of these schools, which I may, for the sake of brevity, call the absolute school, truth is a concept reached by processes of more or less rigid speculation and reasoning, in which, however, introspection plays a large part, explaining the world, reality and mind in terms which are wholly of dialectical coinage. The central doctrine of this system of thought is that reality and appearance are but manifestations of the activity of an entity freed or absolved from all limitations of time and capable of all that we can conceive and more, an entity that is, in consequence, denominated the Absolute. The Absolute is, in the language, some would say, in the jargon, of the school, but truth itself because it is claimed to be the product of the final analysis of the phenomena of mind and reality.

This concept of truth commends itself to minds of a rare type, chiefly those of the cloister or the study, but never to those representative of the world of action. I do not wish to be understood as deriding it or the processes by which it is reached, for I recognize that the human mind must ex-

plore its own depths and exploit its own processes, whatever the result may be, yet I would point that the world is not peopled wholly by Greens, Cairds, Bosanquets, Bradleys and Royces, and that the life and thought of the exoteric many can never but remotely be influenced by this doctrine of truth.

The other school of philosophy is a proponent of a doctrine of truth quite different from the product of pure intellectualism and which can be understood and applied by the many to daily life, and because it can be of service to them it can be absolved from the charge that "it bakes no bread." This school of philosophy holds, as its cardinal tenet, that truth is a body of beliefs or generalizations that work when you apply in it in your needs. The truth in a particular case is the generalization, great or small, that you find in accordance with the facts, and the facts themselves are isolated truths, the products of your experience, that you accept as satisfying your intellectual tests. Whatever works then in daily life is truth, and, if a generalization, or belief, can not be so applied, it has no function or significance intellectually or practically, and can not be truth as it is conceived by the disciples of this school.

This school of philosophy is known as the pragmatic school and it is generally supposed to have been founded within our own time by the late C. S. Pierce and Professor William James, of Harvard, and Dr. F. C. S. Schiller, of Oxford, and Professor John Dewey, of Columbia, who still remain its leaders. The school, however, represents an attitude of mind that has influenced the race since its origin one or more millions of years ago. Ever since the middle of the Pliocene Age, or, perhaps, even since the end of the Miocene, man has had to struggle with his environment, and that very struggle postulated a system of beliefs and generalizations, which, if they served him, represented to him truth. The beliefs and generalizations did not work, if he failed in the struggle and was exterminated. They were, of necessity, at first of the crudest, the most barbaric type and limited in their scope and application to the needs of the moment, but they were changed as they slowly underwent the test of experience, and the beliefs and generalizations of one age were discarded wholly or became the superstitions of succeeding ages. Even to-day the vast majority of mankind regard their beliefs and generalizations as true because they work or give a satisfactory explanation of the scheme of things as it appears now.

That the pragmatic point determined what truth was in the mind of prehistoric man may be gathered from the study of the beliefs and practises of those tribes which are still in the prehistoric stage of culture. Sir John G. Frazer, the author of "The Golden Bough," and one of the profoundest students of the history of human culture, in his work "Psyche's Task" claims that the evolution of some of our most cherished convictions and principles, such as the sacredness of human life, sexual morality, the rights of property and our conception of social order, was promoted by the beliefs and generalizations of prehistoric races. These beliefs and generalizations now appear to us as superstition, and of the grossest character in some respects, but this very superstition in promoting those convictions and principles on which the whole fabric of society rests has rendered a great service to humanity. Sir John Frazer admits that superstition has been productive of evil in the history of the race, but this should not blind us to the

benefit it has conferred, and he gives special point to all this by a dictum which for its brevity and concentrated wisdom is well worth remembering:

> Once the harbor lights are passed and the ship is in port, it matters little whether the pilot steered by a Jack o' lantern or the stars.

The history of the human mind is then that of long ages of discipline in pragmatism. It is the pragmatic mind that has brought man along the road of progress through the million or more years of the prehistoric period to the stage of civilization of to-day. It is the pragmatic mind that will lead him, indeed force him, along the road of progress in the many, many millions of years during which the race will possess the earth. In all that time to come he will refine more and more the processes by which he arrives at what he will regard as truth and he will subject it to ever rigider tests as the millenia pass. As a result, there will be many a discarded belief and generalization once looked upon as truth, just as there has been in the past a long series of beliefs and generalizations which for a time worked and then became superstitions. Truth then will have its paleontology just as life has, with its myriads of forms which have passed away.

To those who are inclined to accept the intellectualist's teachings, this view of truth as earth-born rather than heaven-born, appears repellant and degrading. It does not seem possible for them to idealize it as they can idealize what Carlyle calls "The eternal verities." They, with Chaucer, may hold that "truth is the highest thing a man may keep," and they are prone, accordingly, to sublimate it, as the intellectualist does, until it has no earthly affinities. They should remember that truth of the absolute school has had a repellant history. Men have in the past assumed that they were in the possession of absolute truth and they attempted to compel all others to accept it also. Not to receive the absolute truth, they held, was to murder the soul, and to prevent such murder the extremest cruelty was considered justifiable. Hence arose persecution, religious wars, death at the stake and on the scaffold, massacres of thousands and relapses into barbarism. Absolute truth has then its paleontology to remind it that it, like the truth of pragmatism, is subject to growth, to evolution, and that it may ripen only with the ages.

From all that I have said it follows that the long discussions on the nature of truth as the pure intellectualist understands it have been but vain dallyings with illusory ideas. There is no absolute truth knowable to the human mind. All that passes for such can, at best, be but a remote approximation to what may, in the final cast of thought in the far-distant future, be a dim limning of the ultimate, the absolute, the fundamental significance of the relations of reality and mind.

Now what is the bearing of all this on scientific truth?

Its significance lies in the fact that the representatives of science must always face the question of the validity of its position as an exponent of organized knowledge. There is in the popular mind a notion that the processes by which the facts and generalizations of science are established are different from those which are employed outside of the laboratory or observatory to establish the working hypotheses of daily life, or which were employed, more or less unconsciously, in the development of the most firmly founded principles on which our present social order rests. This has caused science to be regarded as a thing apart, as the lore of an oracle whose pro-

nouncements it is profanity to reject. One hears in popular speech such expressions as "science says . . ." or, "according to science," or "science teaches" and this indicates that in the mind of the average man there is a more or less developed cult of science as an infallible entity, personality, or divinity, which, like Minerva, has no earthly or human origin. It is perhaps not the popular mind that is wholly to blame for this. When one reviews the discussions and polemics of the last fifty years, which have arisen from the conflict between conservative and advanced thought, and, especially, advanced thought based on direct observation and experiment, there has not been wanting a species of dogmatism in not a few of the representatives of science, that suggests the claim of a degree of infallibility which the popular mind, superficial as it is, and because of the achievements of science, has been and is inclined to accept. It is true, the clearest-minded amongst the representatives of science never by speech or silence encouraged such a claim. Tyndall, Huxley, Kelvin, Helmholtz, Virchow and Pasteur have, in set terms, again and again insisted that science is not infallible. Huxley, throughout his long crusade for the recognition of science as a force making for progress, was specially insistent on the possibility of error in science. He it was who defined science as nothing but trained and organized common sense, a definition that ought to acquit it of the charge of claiming infallibility.

In spite of these disclaimers, the taint of a reputation for infallibility remains, and it not infrequently draws from the superficial, as well as from some who ought to know better, the criticism that the judgments of science are unstable and ought not to be regarded as having any validity when they are opposed to the established beliefs and the dogma of the day. Sometimes the exponents of the older learning denounce science as falsely so-called, or term it pseudo-science. At one time that was the stock charge against science, and it had its effect on the unthinking. It still is launched against science chiefly in the polemical publications of the orthodox theological school.

It is, however, when the criticism comes from the rank and file of the army of science that it does the most mischief, and especially so when it is urged in defence, not of religious beliefs or dogmas of a philosophical school, but of dogmas like vitalism, the acceptance of which postulates a negation of the established methods of science.

It is not difficult, though not fair, to charge science with pretensions to infallibility, then to recall its mistakes, its discarded theories and generalizations and thereby to impugn its claims to speak with authority on matters with which it busies itself. That appeals occasionally to the man in the street and it gains a little, perhaps desired, notoriety for the critic, but does it help us in the final cast of things to question the hard-won achievements of the human mind and say that they are naught? By what other methods than those followed in scientific research can organized knowledge be gained? Is it by intuition, revelation or the dialectics and pipe-dreams of the intellectualists? It is, therefore, beside the mark for Von Uexküll to ask "Was ist eine wissenschaftliche Wahrheit?" and to answer "Ein Irrtum von heute." In a different spirit and with a world of difference in ultimate meaning is the observation of Huxley that "history warns us that it is the customary fate of new truths to begin as heresies and to end as superstitions."

Science, then, is not infallible and never can be. Equally lacking is the quality of infallibility in scientific truth. The essence of a truth in science lies in its power to explain phenomena in a satisfactory way. If it does not do this, then it is not a truth. In a certain stage of the development of scientific knowledge a theory is found to explain or relate all the known facts in a particular range of phenomena. This is the source of the satisfaction it gives to the scientific mind and at that stage it is accepted as a truth. But subsequently discovered facts in the same province may refuse to be so explained or related, and the previously accepted truth will, consequently, be discarded for one that will give this service.

An illustration is to be found in the history of the theories of light. Newton held that light emanated from its source in the form of excessively minute particles or corpuscles, which were supposed to travel with enormous velocity. This "corpuscular" theory in his day and for a hundred years after seemed to explain all the then known phenomena of light. It was not only satisfactory in this respect, but it stimulated further inquiry in the subject. This eventually led to the promulgation of the "undulatory" theory, according to which light is but a wave motion in the cosmic ether. For the last hundred years this has been accepted as a truth, but in its turn it is failing to explain all new facts as they are ascertained, and its acceptance in its original form as a truth may eventually terminate.

If this is scientific truth, what is there to prevent it from running riot, confusing and misleading rather than guiding?

The only preventive force is the scientific spirit. It is a development of the quality or tendency of the mind which has compelled man in all the periods of his history to discard or to recast his truths because they do not work, and to accept new ones because they do work. That tendency in common life has operated crudely and slowly, it has caused countless mistakes and the temporary acceptance of countless errors, but it has brought us to our present stage of civilization. It is indeed nothing else than the pragmatic spirit. The scientific spirit is the pragmatic spirit trained in the strictest fashion to accept only what answers rigid tests and reinforced by an intense curiosity or desire to know. The very essence of this spirit is manifested in the habit of unceasing, relentless criticism. Without such incessant criticism there would be chaos in science. The scientific spirit, as thus understood, is an all-powerful factor in establishing scientific truth.

To some of you, perhaps to many of you, what I have said may appear as a restatement of a series of truisms, and I am prepared to admit that. I have, however, dwelt on these matters at length because they are of fundamental importance to men of science generally, and, amongst these, to biochemists, especially of the younger generation, who have now to meet an extraordinary situation in which these matters are involved.

A brief sketch of the history of biochemistry to the present date will demonstrate what this situation is.

It would be difficult to say when the history of biochemistry actually began, for all through the last century a number of contributions to chemistry were made which can now be regarded as contributions to biochemistry. The history of biochemistry, however, as a distinct department of knowledge, may be said to have begun with Hoppe-Seyler in 1867 in the work from his laboratory, which he subsequently published under the general title of "Medicinische-Chemische Untersuchungen." The

number of publications from all sources, which appeared annually during the seventies was small, and even in 1884 when I began to interest myself in the subject it did not, all told, exceed more than three hundred a year. It was possible for a biochemist then and for a few years thereafter to keep in touch with all advances in his subject, but eventually the number grew and in 1905 the year's output of biochemical publications of all kinds was estimated to be about three thousand five hundred papers. It did not cease to grow and the output of 1913 was more than six thousand.

The task of the scientific spirit in 1870, so far as the exercise of relentless criticism was concerned, was easy, for the dozen or more biochemists could supervise the whole field of production and pronounce judgment. That function was carefully and deliberately performed. It is on record that when Miescher, who had been for some time a student in Hoppe-Seyler's laboratory in Tübingen, offered his paper, now classical, on nuclein, for publication in the "Medicinische-Chemische Untersuchungen," Hoppe-Seyler would not publish it till he himself had worked over the whole subject and verified all the observations of Miescher. The publication of the paper was, in consequence, delayed two years.

What could be done in 1870 can not be done now, when the mass of literature being poured out in every department of biochemistry is so overwhelming. It is still possible for the head of a laboratory to censor its productions and a number of the leaders exercise that function, but what they do in this subject ameliorates the situation only to a slight extent. There is still, as any one can see, too little criticism of value in the annual output. One gets the impression, in reviewing the literature on a subject, that the contributors to it regard criticism as not within their province, and that they are anxious to get their own views on record without going through the labor of preparing a critical review of that literature. There is in consequence an ever increasing dependence on Jahresberichte, Centralblätter and Ergebnisse. Even when the function of criticism is exercised the situation is not always thereby bettered, for the criticism not infrequently is slipshod or specious, and the result is only polemics, or it is completely ignored.

It may be urged that the criticism to be effective would increase the length of each contribution, which on the average is sufficiently long already. The answer to this is that effective criticism would in the end not only shorten the length of the papers, but also lessen their numbers.

The haste to publish and the tendency to multiply unnecessarily the number of papers are vices which should be curbed. The fact that they are so prevalent is due to the absence of effective criticism.

In claiming that criticism is the essence of the scientific spirit, I must not be understood as justifying criticism of the undiscriminating or reckless type. That is utterly senseless and is a graver fault than the absence of all criticism. Criticism, to be effective, must be judicial, honest and, above all, courteous to the object of it. Criticism of that type no man can refuse or reject and it is extremely valuable to the individual who is subjected to it, as he will admit sooner or later if he is of the right sort. It is the only means of determining whether what he offers as a contribution is going to work.

To inculcate right standards of criticism there should be given in every university a course of lectures on ethics for all those who propose to devote themselves to a scientific career. There might even be, I would suggest, a brotherhood like the ancient Brotherhood of Hippocrates, the members

of which would vow to devote themselves to the cause of truth, to deal justly and courteously with one another and with all laborers for that cause and to keep the scientific record purged of what is false or mean.

Not to dwell further on this subject, I will now briefly emphasize the central points of this address:

The first is that absolute truth is not knowable, and that even to the end of time it will be so.

> The unfinished window in Aladdin's Tower
> Unfinished must remain.

The second point is that scientific truth of any age is that which works and consequently it may change and present a new aspect with each succeeding generation.

The third is that the scientific spirit is, when rigorously exercised, the only test of what works or what is scientific truth.

The last point is that science is not and never can be infallible, and we should be thankful for that, for, if it assumed infallibility, the progress of the human mind on the path of truth would cease.

Before I conclude finally I would call attention to a rendition of the ideal scientific spirit which is to be found in a passage of Tennyson's "Ulysses." The old hero is there represented as having, after ten long years before the walls of Troy and ten more years of peril and adventure on the sea, returned to Ithaca, his old home, and as now resolving to take up the life of change and discovery even though the gulfs should wash him down. The passage which I quote should be indelibly fixed in the memory of every scientific worker:

> I am a part of all that I have met;
> Yet all experience is an arch wherethro'
> Gleams that untravell'd world whose margin fades
> Forever and forever when I move.
> How dull it were to pause, to make an end,
> To rust unburnish'd, not to shine in use!
> As tho' to breathe were life! Life piled on life
> Were all too little, and of one to me
> Little remains, but every hour is saved
> From that eternal silence, something more,
> A bringer of new things, and vile it were
> For some three suns to store and hoard myself,
> And this gray spirit yearning in desire
> To follow knowledge, like a sinking star,
> Beyond the utmost bound of human thought.

A. B. MACALLUM
UNIVERSITY OF TORONTO

EUGENE WOLDEMAR HILGARD, A BIOGRAPHICAL SKETCH

EUGENE WOLDEMAR HILGARD was born January 5, 1833, at Zweibruecken, in Rhenish Bavaria, the son of Theodore Erasmus and Margarethe Hilgard, and was the youngest of a family of four sons and five daughters. His father was a lawyer, holding the position of chief justice of the court of appeals of the province. Judge Hilgard, having been born and educated under the shadow of the French Revolution, and being of pronounced liberal views, stoutly opposed the supersedence of the code Napoleon by the illiberal laws of the old régime. In 1836, when at the fullness of a successful career, he determined to emigrate to America with his family and settled on a farm at Belleville, Illinois. As the public schools of that day were quite primitive, Judge Hilgard personally undertook the preparation of his sons for entrance to the universities. Eugene was in readiness in 1849 and in that year returned to Germany to attend the University of Heidelberg, graduating with honors and a doctor's degree with *summa cum laude* in 1853. This degree was re-issued to him in 1903 as a "golden degree" in recognition of half a century's good work for science. He studied also in Zurich and Freiberg, in Saxony. After graduating in 1853 he visited Spain and met Miss J. Alexandrina Bello, daughter of Colonel Bello, of the Spanish army, whom he married several years later. Returning to America, he began geological exploration work in Mississippi in 1855 and was appointed state mineralogist of that state in 1858. In 1860 he revisited Spain, married

Miss Bello and resumed his work in Mississippi in November of that year. During the intervention of the Civil War he pursued the chemical work required by the Southern Confederacy. In 1866 he was chosen professor of chemistry in the University of Mississippi, and later professor of geology, zoology and botany. In 1872 he left Mississippi to take a position on the faculty of the University of Michigan, but remained there only two years, when he was called by the regents of the University of California to California in 1874. While developing agricultural instruction in the university, he proceeded with research work immediately after his arrival in California and published his first results in 1877. His work in the investigation of soils in connection with their native vegetation, of the influence of climate on the formation of soils and especially of the nature of "alkali soils" and their reclamation, a problem quite new not only in this country but in other arid regions, achieved for him a reputation as wide as the world of science. It brought him recognition on numerous occasions. Mississippi, Columbia and Michigan universities, as well as the University of California, have bestowed the Doctor of Laws degree upon him. The Academy of Sciences of Munich presented him with the Liebig medal for distinguished achievements in the agricultural sciences and the international exposition at Paris, in 1900, gave him a gold medal as a collaborator in the same research.

Soon after coming to California he directed the agricultural division of the northern transcontinental survey. From 1879 to 1883, in connection with his university work, he assumed charge of the cotton investigation of the census of 1880 which he projected and carried out on a broader plan than ever before undertaken. During the whole period of his academic career Professor Hilgard was constantly active in authorship. In addition to formal reports and memoirs, he wrote much for agricultural and scientific periodicals. His greatest book is "Soils of Arid and Humid Regions." The simple form of this work is "Agriculture for Schools of the Pacific Slope," undertaken in collaboration with Professor W. J. V. Osterhout, formerly of the University of California.

In 1892 he revisited Europe and was received with distinguished honor by his colleagues in science in the German universities and experiment stations, and by invitations to deliver public addresses on the subjects in which he had made the chief achievements.

Since 1910 Professor Hilgard's advanced age rendered him unequal to the pursuit of extensive tasks. He maintained, however, his membership in several scientific societies and was vitally interested to the last in investigations connected with his science.

The greater part of Hilgard's career was spent at the University of California. Of the many and various problems which he faced at the beginning of his work there, three seem at this moment to give best clue to the masterfulness of the man and fullest understanding of the breadth and depth of his success:

First: the conciliation and conquest of his farming constituency, by demonstration of practical and indispensable value in the work he could do.

Second: the enforcement of recognition of agricultural studies as entitled to the dignity of higher learning and as possessed of pedagogic value.

Third: the securing of funds to pursue research which could alone yield truth about natural conditions affecting California farming, and to increase his working force, without which he could neither get the truth nor teach it in its several branches and applications.

I clearly recall an early instance of Hilgard's method. I was present at a farmers' meeting in San Francisco in 1876, apparently called to see just how far the college of agriculture at the University of California had fallen. The room was not large and was crowded with men of some prominence in farming and hostile to the university because they really believed that the college of agriculture ought to be snatched from ruinous association with a so-called "classical institution." It was a stormy assembly, but when

there came a lull the chairman asked Hilgard to speak. He rose alertly, showing them a slim, graceful figure, and when he had folded and pocketed the blue glasses which a long-continued eye trouble forced him to wear, they saw a scholarly face illumined with an eagerness, cordiality and brightness of expression which seemed to say to them: I never was in such a delightful place before in my life. Before he could say a word he had them transfixed with surprise and curiosity, and when he began to speak in a low, conversational voice, with an accent which compelled them to listen closely, every man was at attention. He was saying that he was glad to meet them; that no one could do much for farming unless he had personal knowledge and support of farmers; that he had listened with interest to what they had been saying and much of it doubtless would be helpful to him; that other things they could talk over and agree upon when they became better acquainted; that he had come to California to try, with their help and support, to know California, from the rocks to the sky, and proposed to use all that he had learned in other lands merely as a help to begin to know California, which he already perceived was different from any other land in which he had lived and worked. He wished to work from California outward, not to try to fit old theories to a new state. He had always been interested in differences and wanted to see what they were and how they worked in farming. On his father's farm in Illinois he learned that the soil was not all alike and he had been told that soil differed when it came from different rocks, when it was moved about in different ways, and when other things were mixed with it, and that since boyhood he had been studying the rocks, the soils, the plants, to see what was in the soil and in the plant in the hope of matching them up to get the best crops and the most money in farming. Then followed a charming half-hour with soil formation and movement, tillage, fertilization, etc., without a scientific term, without reference to a chemical formula, all straight farming talk about soils and plants. Finally he said he had come to find out how these things worked in California.

Within a few years Hilgard was able to render his first great service to the community in which he lived by promoting a sympathetic understanding between the farmers of the state and scientific learning, so that the college of agriculture became firmly established as a part of the state university by constitutional amendment. The influence of this achievement was wide-reaching, for it has proven a rock upon which efforts for dismemberment of land-grant universities in other states have been dashed to pieces.

Hilgard's scholarly preparation was wide. Aside from scientific branches, he knew his Latin and his Greek and the literatures of them, and only the distinguished professor of German of that day could surpass him in conversational scope in modern languages. And he loved all this learning and constantly used it familiarly, while, beyond all conscious employment of it, there it was forming his thought, gracing his style and in every way influencing his action and enriching his life.

He was thus able ultimately to command the interest and respect of both the scientific and classical portions of the university community in his service to the state. He was always broader than his own science. He was a real man and a true philosopher.

Hilgard's work was permanently successful because with clear vision he founded it upon principles the soundness of which has since been demonstrated and generally recognized. In his first report, published in 1877 he said:

> A knowledge of facts and principles and not the achievement of manual dexterity, must be the leading object of a truly useful course of instruction in agriculture. . . . Object teaching should be made the preeminent method of instruction in natural, and more especially in technical science. Manual exercise should be made the adjunct of the instruction in principles.

Thus Hilgard announced at the very beginning his adoption of the laboratory and field method of instruction and he pursued it so far as he could command the outfit for it.

That the structure of Hilgard's achievements in the University of California was his own from the ground up, appears from another extract from his first report.

The appropriation of $250 for the beginning of an experiment station has, under advice, been carefully husbanded by me after the failure of the appropriations asked of the last legislature, in order to insure the continuation of the home work.

Fortunately the legislature of 1877 gave him $5,000 for two years and the legislature of 1879 gave $5,000 a year for two years, of which he says, in his report for 1880, "it barely enables us to pay running expenses, and farther improvement and increase of scope will be impossible"; for he then had half a dozen field and laboratory assistants to provide for. At the same time, however, that his local patrons and employers were wondering how Hilgard could use $2,500 for expense money, the United States gave him not less than $25,000 to spend in his cotton work.

The stand taken by Hilgard with reference to the dignity and pedagogical value of agricultural science, while so many institutions, now great, were in their formative periods, was recognized as sound throughout this country and beyond. Set forth in his early reports, it exercised a profound influence. The proper relation of agricultural practise to agricultural science, as factors in educational effort; the educational distinction between labor performed for enlightenment and labor prescribed to beget a liking for labor; the place of both the art and science of agriculture in a university of higher learning, when both are handled ably for instructional purpose—these were among his fundamental contentions, upholding them through many controversies, and his victory is seen in their entry into the regular curricula of all of the newer institutions of learning and their pursuit by older institutions established upon other standards of learning before the existence of these educational factors was dreamed of as worthy and capable.

Hilgard's strategic diversion of 1879 to 1883 was one of the brightest and most effective movements of his career. On the basis of his work in Mississippi he was requested by the director of the census of 1880 to take full charge of the cotton investigations for that census and to do something greater for the cotton industry than was ever done before and he was promised funds for inquiry, investigation, laboratory work and whatever else he deemed necessary to get at the fundamental facts and principles connected with cotton growing in the United States. He reviewed the subject as a whole and in divisions, studied each cotton state and finally, after four years of work, produced in two volumes his report upon the cotton industry of the United States, a lasting benefit to all cotton-producing states. This report, in two quarto volumes, was a force in engrafting original research upon the instructional work, established through the educational land-grant law of Morrill, by the enactment of the Hatch law for state experiment stations in all states.

The results of Hilgard's labors are in the warp of California's first half-century of intellectual and industrial life. He was quick to see his opportunities for public service, to recognize his duty therein and he was masterful and tireless in pursuit of it. He was bold in conquest of truth and fearless in his use of it for the interest of mankind, seizing gladly the smallest fact from research and pressing it to the humblest service but always perceiving and enforcing the relations of both the fact and the service to the broadest interests of his states and of his fellow men. Thus all came to know him as richly wise, unswervingly true, and deeply patriotic and humanistic—a man whose thinking was as clear and whose motives were as unselfish as his service of them was forceful and effective.

E. J. Wickson
University of California

THE SCIENTIFIC WORK OF EUGENE WOLDEMAR HILGARD

Eugene W. Hilgard accepted the position of assistant state geologist of Mississippi in 1855, at the age of twenty-two, but was well equipped for scientific investigations of any kind. He had spent his early boyhood days on a farm, giving his spare hours to the reading of standard works on chemistry and botany and in making collections of plants and insects; then in later years had completed his

scientific training at Heidelberg, Zurich and Freiberg, taking for his graduating thesis the candle flame, in which he was the first to define four parts and to give the chemical processes in each. Thus well trained in the natural sciences, especially in physics, chemistry, botany and geology, with a keen mind, quick and accurate in his observations, and with a remarkable memory, he entered upon the work of the survey with enthusiasm, although the field seemed very unpromising from a geologist's standpoint. He traveled over the state with the state geologist, making observations and collecting material for study. The state geologist, however, failed to make a satisfactory report to the legislature and the survey was suspended, Hilgard returning to Washington as chemist in the laboratory of the Smithsonian Institution and lecturer on chemistry in the National Medical College. In 1858 he was appointed state geologist of Mississippi and resumed his detailed investigations of the geology, botany and agriculture of the state.

One of the chief characteristics in Professor Hilgard's nature was the extreme care, accuracy and attention to detail that he gave to everything he undertook. This is strongly shown in the results of the Mississippi survey, which will ever stand as a tribute to his high standing as a geologist.

Mississippi, because of its large proportion of virgin soils, seems to have been especially well adapted for researches in soil character; and in his geological survey of the state, Hilgard was quick to note the sharply outlined differences in the native tree and plant growth on the several types of soil, and especially the differences in behavior and durability of soils under continued cultivation. He therefore determined to make these the subject of special study in order that the farmers themselves might gain some benefit from the survey. Thus were begun those studies of the chemical, physical and other properties of soils that became his life work, and which, reaching out into other states and other countries, have brought to him honor and renown over the entire civilized world. In 1860 was printed his report on the Geology and Agriculture of Mississippi, a volume of 391 pages in which were given in detail his observations on the geological and agricultural features of the state with chemical analyses of many of the soils. The geological map which accompanied the report also presented the soil divisions which closely followed the geologic changes.

During the civil war Hilgard was placed in charge of the buildings and equipment of the University of Mississippi by the governor, and when its faculty was reorganized at the close of the war he was made professor of chemistry, which title was in 1871 changed to that of professor of experimental and agricultural chemistry; but though relinquishing the position of state geologist to others he continued his interest in the further study of the geology of the state, and of the other southern states. In 1867, at the request of the Smithsonian Institution he made an examination of the Mississippi River delta, the rock salt deposit of Petite Anse Island, and the cause of the formation of the mud-lumps in the passes of the river; and later a geological reconnaissance of Louisiana for the New Orleans Academy of Sciences. The results and discussions of these examinations are published in a number of reports and papers.

Professor E. A. Smith, state geologist of Alabama, says of Professor Hilgard's geological work in Mississippi and Louisiana:

> When in 1855 Dr. Hilgard accepted the position of assistant geologist of Mississippi there began the career of the most distinguished worker in Gulf Coastal Plain Geology, and the fame which he won for himself in this "uninteresting" field is known to all geologists. He has laid the foundation on which most subsequent work in the "Mississippi Embayment," as he named it, securely rests, and after the lapse of more than fifty years since the publication of his report in 1860 his work is appreciated and referred to as authoritative not only by the farmers and other citizens of that state, but by the geologists who have succeeded him.
>
> In the excursions down the Mississippi River and through Louisiana the post-Pliocene of the Port Hudson "stump stratum," and by inference

at least its extension from the Sabine River to Mobile Bay were definitely determined, and the Coast Pliocene of the 1860 map was changed to Port Hudson. The results of these expeditions may be summarized as follows:

1. The outlining of the Mississippi Embayment in Louisiana and Mississippi.

2. The outline geological study and mapping of these two states. He was the first to give a clear and definite account of the origin and distribution of the surface formation which he called the Orange Sand, now known as Lafayette. He was the first to give a definite account of the great series of river and estuarine deposits, "the Grand Gulf," representing all geological time between the Vicksburg and the Lafayette.

3. The recognition of the Cretaceous Ridge, or the backbone of Louisiana, and the determination of the Cretaceous age of the rock-salt and sulphur deposits of Calcasieu parish.

4. The study of the exceptional features of the Lower Mississippi delta and of the mud-lumps and the definite correlation of the Port Hudson formation.

Probably no work has done more for the correlation of the scattered accounts of the geology of the southern states than the Cotton Culture Reports of the Tenth Census prepared under the direction of Dr. Hilgard. In these a summary of the physical and geological features of each state is first given. Then follow accounts of the agricultural features and capabilities of the cotton states, such as would be of interest to immigrants and investors, along with special descriptions of each county, with soil maps and many soil analyses; altogether the reports are reliable handbooks of the cotton states as regards general and agricultural information, and deserve to be more widely known than they are.

On coming to California in 1875 as professor of agriculture in the state university, Hilgard entered upon his greatest field of activity; and from the very beginning, when he laid the strong foundation for the college of agriculture and experiment station of the University of California to the later years when he witnessed the immense results of his labor, he displayed the same remarkable energy, indomitable will and perseverance as well as the hearty comradeship and readiness to help that characterized his work in Mississippi and which gained for him hosts of friends and supporters. He was always ready to give freely of that great and varied store of information of which he was possessed.

Among his California activities there stand out most prominently his studies on humid and arid soils, and especially his researches into the cause, occurrence and effect of alkali salts upon vegetation, and the methods to be used in neutralization and reclaiming alkali land. He was the first to enter upon this field of study, the results of which have been extensively quoted and his bulletins published in other countries where alkali lands exist.

His report on cotton production and the soil regions and soil characteristics of the cotton-producing states, made for the Tenth U. S. Census and comprising two large quarto volumes is a highly valuable work; and his book of about 600 pages on "Soils" is also the highest authority on arid and humid soils.

The mind and hand of Hilgard were never idle, and while engaged in solving old problems in relation to soil fertility and plant life he was ever on the alert for new ones. The results of his activity are shown in the hundreds of published articles in the station reports, outside journals, both foreign and domestic, government publications, etc. During the thirty-five years of active service in the University of California he allowed himself but one vacation of a year and that was spent abroad. A few weeks were given to a survey along the northern transcontinental railroad and a few weeks to a visit to his Mississippi geological locations.

While Hilgard was not the first to make a soil survey and chemical analyses of soils he was the first to interpret the results in their relation to soil durability, fertility and crop production. He was the first to maintain that the physical qualities and chemical characters of a soil go hand in hand in determining its cultural value and he maintained that the complex character of a soil demanded an investigation into its chemical, physical, mineral and biological characters if we would understand it fully. His broad and thorough scientific knowledge, his great work on soils and his valuable publications brought him

many honors, among them the degree of LL.D. from the universities of Mississippi, Michigan, Columbia and California; the Liebig gold medal from Munich, and others from the expositions of Paris, Rio de Janeiro and St. Louis, as well as the offer of Assistant Secretary of Agriculture from President Harrison.

Although much reduced in vitality during the last three years of his life as the result of an injury, his interest and desire for service in the cause of agriculture were keen and virile, and his great regret, daily expressed to the last, lay in his inability to further pursue his studies of soil and other problems.

R. H. LOUGHRIDGE
UNIVERSITY OF CALIFORNIA

THE INDUSTRIAL FELLOWSHIPS OF THE MELLON INSTITUTE

SOME of the important recent events in connection with the operation of the practical system of cooperation between science and industry at the Mellon Institute of Industrial Research of the University of Pittsburgh, have been reported during the past year in this journal. I allude especially to the dedication of the permanent building of the institute,[1] the establishment of a school of chemistry at the University of Pittsburgh,[2] and the inauguration of Professor M. A. Rosanoff as head of the department of research in pure chemistry of the Mellon Institute.[3] In addition, there has been occasion to communicate elsewhere accounts of the graduate school of specific industries of the Mellon Institute[4] and a discussion of the principles involved in the administration of endowed industrial research laboratories.[5] However, almost two years have elapsed since the last report was made to SCIENCE[6] on the status of the system of industrial fellowships initiated by the late Dr. Robert Kennedy Duncan at the University of Kansas and later, on September 1, 1911, transferred to the University of Pittsburgh.

The progressive growth in both the number of industrial fellowships in operation and in the amounts subscribed for their maintenance, is shown in the following table.

Academic Year	Number of Fellowships in Operation	Number of Fellows	Amounts Subscribed for the Maintenance of Fellowships
1911–12.....	11	23	$39,700
1912–13.....	16	30	53,500
1913–14..	15	29	59,100
1914–15.....	24	42	74,350

It is of interest to note that when the industrial fellowship system passed out of its experimental stage—when the Mellon Institute moved into its permanent home in February, 1915—twenty-three fellowships were in operation. At the present time (March 1, 1916) there are thirty-six fellowships and two additional ones have recently been arranged for, to begin later in the year. Sixty-three industrial fellows are engaged on the fellowships now in operation. The growth of the institute has about reached the stage where we shall be obliged to decline further industrial investigations for the present, since our laboratories are almost filled up to capacity.

A LIST OF THE INDUSTRIAL FELLOWSHIPS IN OPERATION AT THE MELLON INSTITUTE ON JANUARY 1, 1916

No. 19: Aluminum.—$5,000 a year for two years; $5,000 a year for the third year. Bonus: $10,000. Fellows: Lester A. Pratt, Ph.D. (University of Pittsburgh); Hugh Clark, Ph.D. (University of Pittsburgh); F. D. Shumaker, B.S. (University of Pittsburgh). (June 1, 1913.)

No. 28: Fertilizer.—$2,500 a year for three years. Bonus: $5,000. Fellow: Earl S. Bishop, M.A. (University of Nebraska). (January 5, 1914.)

[1] Hamor, SCIENCE, N. S., 41 (1915), 418. See also Hamor, *J. Ind. Eng. Chem.*, 7, 326; *Met. Chem. Eng.*, 13, 266, and *Eng. Min. J.*, 99, 480.

[2] SCIENCE, N. S., 42 (1915), 491. See also *Met. Chem. Eng.*, 13, 782; *J. Ind. Eng. Chem.*, 7, 1,002, and *Univ. Pgh. Bull.*, 11, No. 23.

[3] Hamor, SCIENCE, N. S., 42 (1915), 636. See also Bogert, *ibid.*, 737.

[4] Bacon, *J. Ind. Eng. Chem.*, 7, 343; *J. Frank. Inst.*, November, 1914, 624.

[5] *J. Soc. Chem. Ind.*, 35 (1916), 18–27.

[6] Duncan, SCIENCE, 39 (1914), 672.

No. 34: Fatty Oils.—$2,100 a year for two years. Fellow: Leonard M. Liddle, Ph.D. (Yale). (July 1, 1914.)

No. 43: Laundering.—$1,800 a year for one year. Fellow: Harvey G. Elledge, B.S. (University of Kansas). (February 15, 1915.)

No. 44: Land Development.—$1,000 a year for one year. Fellow: Will E. Vawter, B.S. (University of Kansas). (February 1, 1915.)

No. 45: Copper.—$2,000 a year for one year. Fellow: Albert S. Crossfield, B.S. (University of California). (April 19, 1915.)

No. 46: Organic Synthesis.—$6,000 a year for one year. Bonus: $5,000. Fellows: Harold Hibbert, D.Sc. (Victoria University), Senior Fellow; H. A. Morton, Ph.D. (University of Pittsburgh); H. J. Little, B.S. (Delaware College). (July 1, 1915.)

No. 47: Soda.—$3,000 a year for one year. Fellow: C. W. Clark, Ph.D. (University of Pittsburgh). (September 7, 1915.)

No. 48: Bread.—$6,500 a year for two years. Bonus: $10,000. Fellows: Henry A. Kohman, Ph.D. (University of Kansas), Senior Fellow; Truman M. Godfrey, B.S. (University of Kansas); Lauren H. Ashe, B.S. (University of Pittsburgh). (March 1, 1915.)

No. 49: Candy.—$1,800 a year for one year. Fellow: C. A. Neusbaum, A.B. (Wabash College). (July 1, 1915.)

No. 50: Paint.—$1,500 a year for one year. Fellow: J. V. Thompson, A.B. (Cornell University). (September 1, 1915.)

No. 51: Yeast.—$2,800 a year for two years. Fellow: Ruth Glasgow, M.S. (University of Illinois). Scholar: T. A. Frazier (University of Pittsburgh). (September 1, 1915.)

No. 52: Ores.—$5,400 a year for one year. Fellows: Harry P. Corliss, Ph.D. (University of Pittsburgh); C. L. Perkins, B.S. (New Hampshire College); C. L. Weirich, M.S. (University of Pittsburgh). (July 1, 1915.)

No. 53: Copper.—$3,600 a year for one year. Fellows: Charles O. Brown, A.M. (Cornell University); Ernest D. Wilson, Ph.D. (University of Chicago). (July 1, 1915.)

No. 54: Dental Supply Trade.—$2,300 a year for one year. Bonus: royalty. Fellow: C. C. Vogt, Ph.D. (Ohio State University). Adviser: H. E. Friesell, Dean, Dental School, University of Pittsburgh. (July 1, 1915.)

No. 55: Pharmaceutical Products.—$13,000 a year for one year. Fellows: J. R. Watson, B.Sc. (London University); R. A. Dunphy, Ph.D. (University of Pittsburgh); H. W. Huntley, M.A. (University of Wisconsin); J. B. Churchill, B.S. (Harvard); R. N. Mullikin, Ph.D. (Johns Hopkins); E. P. Wightman, Ph.D. (Johns Hopkins); R. W. Harris, M.S. (Ohio State University). (July 7, 1915.)

No. 56: Soap.—$2,000 a year for one year. Fellow: Ben H. Nicolet, Ph.D. (Yale). (June 26, 1915.)

No. 57: Glue.—$1,800 a year for one year. Fellow: Ralph C. Shuey, B.S. (University of Kansas). (July 1, 1915.)

No. 58: Industrial Engineering.—$2,000 a year for one year. Fellow: Rudolph McDermet, M.S.E.E. (University of Illinois). (September 1, 1915.)

No. 59: Milling.—$2,500 a year for one year. Fellow: H. C. Holden, M.S. (New Hampshire College). (September 1, 1915.)

No. 60: Collars.—$2,300 a year for one year. Fellow: H. D. Clayton, B.A. (Ohio State University.) (October 1, 1915.)

No. 61: Synthetic Inorganic Chemistry.—$6,000 a year for two years. Bonus: $3,500. Fellow: Charles S. Palmer, Ph.D. (Johns Hopkins). (October 15, 1915.)

No. 62: Gas.—$6,500 a year for one year. Fellows: James B. Garner, Ph.D. (University of Chicago), Senior Fellow; J. E. Underwood, M.A. (Wabash College); F. W. Padgett, M.S. (University of Pittsburgh). (September 15, 1915.)

No. 63: Peas.—$1,200 a year for one year. Fellow: E. H. Taylor, M.S. (University of Illinois). (November 1, 1915.)

No. 64: Petroleum.—$10,000 a year for one year. Bonus: $10,000. Fellows: B. T. Brooks, Ph.D. (University of Göttingen), Senior Fellow; I. W. Humphrey, B.S. (University of Kansas); Harry Essex, Ph.D. (University of Göttingen); D. F. Smith, M. S. (University of Wisconsin). (September 1, 1915.)

No. 65: Compound Fats.—$2,800 a year for one year. Fellow: Edmund O. Rhodes, M.S.

(University of Kansas). Scholar: R. Lee Wharton (University of Pittsburgh). (October 1, 1915.)

No. 66: Glycero-Phosphates.—$1,500 a year for one year. Bonus: 10 per cent. of profits. Fellow: Frank F. Rupert, Ph.D. (Mass. Inst. Tech.). (October 1, 1915.)

No. 67: Glass Bottles.—$2,100 a year for one year. Fellow: John F. W. Schulze, Ph.D. (Clark University). (December 1, 1915.)

No. 68: Illuminating Glass.—$900 a year for two years. Fellow: A. H. Stewart, A.B. (Washington & Jefferson). (October 1, 1915.)

No. 69: Linoleum.—$2,500 a year for one year. Fellow: Lester E. Cover, B.S. (Pennsylvania State College). (November 1, 1915.)

No. 70: Gum.—$2,500 a year for one year. Bonus: $6,000. Fellow: M. A. Gordon, B.S. (Cornell University). (November 15, 1915.)

No. 71: Stoves.—$2,300 a year for one year. Fellow: A. E. Blake, M.S. (University of Pittsburgh). (October 20, 1915.)

No. 72: Copper.—$6,500 a year for one year. Fellows: E. R. Weidlein, M.A. (University of Kansas); G. A. Bragg, B.S. (University of Kansas). (November 1, 1915.)

No. 73: Illumination.—$6,000 a year for one year. Bonus: $5,000. Fellows: George O. Curme, Ph.D. (University of Chicago), Senior Fellow; H. B. Heyn, B.S. (University of Wisconsin); Glen D. Bagley, M.S.E.E. (University of Illinois). (November 15, 1915.)

No. 76: Coal Tar Products.—$11,000 a year for one year. Fellows: R. R. Shively, Ph.D. (University of Pittsburgh); F. R. Peters, A.B. (Wabash College). (Three more Fellows to be appointed.) (December 1, 1915.)

Special Research Work.—R. P. Rose, M.S. (University of Kansas); R. W. Miller, M.S. (Kansas State College).

The conspicuous success which has attended the development of the system of service to industry founded by Dr. Duncan may be attributed to several factors. First among these, however, is the research strength of the Mellon Institute; this investigative power has resulted from the facilities for research and has been developed by the administrative staff. It has inspired an abiding confidence among industrialists and has eventuated in the consequent renewal, year after year, of industrial fellowships in fields which require constant inquiry, such as those represented by the fellowships numbered 19, 48, 51, 52, 53, 54, 57, 58, 64, 67, 68 and 72.

Several of the multiple fellowships—ones which have the intensive services of two or more researchers under the direction of a senior fellow—established at the Mellon Institute have been effectively at work since the foundation of that institution, and a number of investigations utilizing the services of one man—individual fellowships—have been promoted continuously for the past three years. Thus, although this must be regarded as a very short interval in the career of an institution whose history should be measured by decades, it has been long enough to afford opportunities for the development of ideas and ideals concerning the conduct of industrial research. The practical results of the research experience of the Mellon Institute are rich in applicable instruction and should be useful to the independent organizations which will probably enter the field of industrial research in the near future.

The proposal has been made to establish state industrial research bureaus, to be conducted along the same general administrative lines as the various agricultural experiment stations, and some progress has, in fact, been made in this direction, for the University of Kansas has, in its department of chemistry, a division of state chemical research. Then, too, the Royal Canadian Institute has lately inaugurated a bureau of scientific and industrial research, based upon the system in operation at the Mellon Institute, and several educational institutions are contemplating similar steps in England.[7] The experience of the industrial research institutions now in operation, which is certain to be drawn upon heavily in the movement to make the research work of the

[7] For English appreciations of the system of industrial research in operation at the Mellon Institute, see Sir William Ramsay and G. G. Henderson, *J. Soc. Chem. Ind.*, 34, 751 and 753; and Humberstone, *Quart. Rev.*, 224, Nos. 445, 521.

country national in both scope and effort, should be readily available for use by their prospective allies. Their entrance into this field should be warmly welcomed. No greater good fortune could come to the Mellon Institute, for example, than a division of labors with a number of similarly well-founded establishments.

In keeping with this attitude of welcome towards prospective industrial research organizations, it is important to add that with them no relations can be stable and helpful, but relations of reciprocity. Cooperation is just as essential among research laboratories as it is among the members of a research team. I may therefore be permitted to indicate one serious danger in connection with the establishment of industrial fellowships which is of concern to the Mellon Institute, and that is the danger that, in order to obtain fellowships, the heads of research departments will "let down the bars." In other words, that they will modify the conditions under which industrial fellowships are accepted at the Mellon Institute. This would be a very serious matter and might lead ultimately to the failure of the whole plan.

The administration of the Mellon Institute is now constituted as follows:

Raymond F. Bacon, Ph.D., director;
Samuel R. Scholes, Ph.D., assistant director;
E. Ward Tillotson, Jr., Ph.D., assistant director;
John J. O'Connor, Jr., M.A., assistant director;
William A. Hamor, M.A., assistant to the director;
Martin A. Rosanoff, Sc.D., head of the department of research in pure chemistry.

Raymond F. Bacon

THE NEW JERSEY MOSQUITO ASSOCIATION

This organization, which has for its object the elimination of the mosquito from the standpoint of human comfort and the attendant property values, held its third annual meeting on February 17 and 18. As might be expected from its purpose the membership is composed of business and professional men of all sorts. To become a member it is merely necessary to inform the proper persons that one wishes to become connected with the movement. No dues or assessments are levied upon the individual members and the necessary expenses are borne by the organizations which belong to it.

The program of this meeting included five speakers, who were professionally connected with the practical work; eleven who were identified with it as members of directing boards; two who were responsible for the state work and the correlation of the work of the county units; three who represented the taxpayers who received the benefits and pay the bills; one who represented the Interstate Anti-mosquito Committee; and one who represented the mosquito work of the country as a whole.

One member of the first group, Mr. James E. Brooks, showed that dikes, tide gates, and trenching drain shut-in areas of salt marsh, which the ordinary trenching will not protect, in such a fashion that no serious emergence of mosquitoes takes place. Another member, Mr. William Delaney, pointed out that pumps are necessary on certain enclosed marshes that have shrunken below the sea level, and that a twelve-inch, low-head, motor-driven, centrifugal pump with necessary trenching removed the water from 800 acres of bad breeding marsh in such a fashion that no serious emergence could occur.

Another member of this group, Mr. Harold I. Eaton, showed that the average acre cost of salt-marsh trenching for 12,000 acres drained in the last three years was $4.00, and that the price exclusive of administration expense had been reduced from $5.22 in 1913 to $2.75 in 1915. Another member, Mr. Russell W. Gies, showed that the average per capita cost of county-wide mosquito control work was about 12 cents. Another, Mr. John Dobbins, pointed out the methods, which four years' experience in the practical work had proved to be best for fresh water mosquito control.

The members of the second group, Dr. Wm. Edgar Darnall, Mr. E. B. Walden, Mr. Joseph Camp, Mr. Spencer Miller, Dr. H. H. Brinkerhoff, Mr. Chas. Deshler, Mr. Ira Barrows, Mr.

Walter Hudson, Mr. Robert F. Engle and Mr. Louis J. Richards, confined their statements to the status of the practical work in the counties which they represented.

The first member of the third group, Dr. Jacob G. Lipman, pointed out the tremendous agricultural and urban development which awaits the satisfactory control of the mosquito pest. The second, Dr. Thomas J. Headlee, pointed out the various problems of the New Jersey mosquito's natural history and control that have been recently solved and some of those which still await solution.

The members of the fourth group, Mr. Thomas Mathias, Mr. E. Morgan Barradale and Mr. John N. Cady, devoted their attention to the results of the work (which they said were good) and the esteem (which they said was high) in which it is held by those who pay the bills.

Dr. Haven Emerson, commissioner of health for New York City, and member of the fifth group, outlined the work of this committee as one of correlating the mosquito control work of Connecticut, New Jersey and New York.

Dr. L. O. Howard discouraged the use of bats as a means of mosquito control in New Jersey on the ground that natural conditions did not favor the attempt. He set forth the work of King, connecting *Anopheles punctipennis* Say with the carriage of malaria and gave a brief account of the bureau's work against the malarial mosquito in the lower Mississippi valley.

The following officers were elected for the ensuing year: *President*—Wm. Edgar Darnall, M.D., Atlantic City; *First Vice-president*—H. H. Brinkerhoff, M.D., Jersey City; *Second Vice-president*—Robert F. Engle, Beach Haven; *Secretary-Treasurer*—Thomas J. Headlee, Ph.D., New Brunswick.

The proceedings will be published.

REPORT OF THE PACIFIC COAST SUBCOMMITTEE OF THE COMMITTEE OF ONE HUNDRED ON RESEARCH

THE Pacific Coast Subcommittee, appointed in the spring of 1915 by the Committee of One Hundred on Research, has held three meetings. The policy which the subcommittee hopes to follow is expressed in a statement adopted at the first meeting:

1. The relation of advances in pure and applied knowledge to intellectual and economic progress and to good government should be made clear to individuals and to communities at every opportunity.

2. The publication of timely and accurate popular articles making known to the people the results of research should be encouraged.

3. The committee should be informed concerning researches now in progress in the Pacific region. This information need not be carried to extreme detail.

4. The committee should lend assistance to investigators who are handicapped in any way. In special cases it may be possible to assist with grants of money from the American Association, or from other sources.

At the last meeting of the committee the following resolutions were adopted:

I. RELATING TO THE PAYMENT OF THE TRAVELING EXPENSES INCURRED BY INVESTIGATORS IN ATTENDING SCIENTIFIC MEETINGS

(*a*) Attendance upon meetings of scientific societies constitutes a necessary element in the life of investigators.

(*b*) The comparative isolation of the Pacific region from other centers of educational activity is a deterrent influence upon many workers in this region.

(*c*) The financial burden laid upon the investigator who would occasionally attend meetings in the eastern part of the United States is often too great to be borne out of his income.

(*d*) Experience has shown the wisdom of the practise of certain institutions (in this country, and especially in Europe) in contributing all or a part of the expenses incurred by their officers in attending scientific meetings.

This committee therefore urges upon the governing bodies of the universities and colleges of the Pacific region the adoption of some plan whereby, *in approved cases,* modest

grants of money may be made to enable members of their staffs to attend meetings of standard societies held east of the Rocky Mountains, *initial action* to be taken in each case, on its merits, by a suitable advisory committee of the institution concerned.

II. RELATING TO GRANTING OF SABBATICAL LEAVE ON FULL PAY FOR RESEARCH DUTY

(*a*) Research by a university professor is a function not less important than teaching.

(*b*) It frequently happens that a professor's time and energy are so completely absorbed by the work of teaching that research becomes impracticable.

(*c*) It occasionally happens that a teacher, imbued with the spirit of research, spends his sabbatical vacation at a reduced salary in the pursuit of his researches.

This committee therefore urges upon the governing bodies of the universities and colleges of the Pacific region the inauguration of the practise of granting sabbatical leave on full pay *in approved cases,* based upon the presentation of *a definite program* of work leading to *a printed report* upon its completion, *initial action* to be taken in each case, on its merits, by a suitable advisory committee of the institution concerned.

Among the subjects which have given this committee concern is the responsibility of scientists in the United States for the progress of research during and immediately following the European war. Will the impoverishment of governments curtail the support of science in Europe, or will the demonstrated efficiency of scientific methods induce the governments to maintain scientific research at a sacrifice of something else? Whatever the outcome may be, the obligations of American men and women of science to push forward the boundaries of knowledge are certain to be increased.

(Signed) D. H. Campbell,
W. W. Campbell,
F. G. Cottrell,
E. C. Franklin,
J. C. Merriam,
Chairman of the Subcommittee

SCIENTIFIC NOTES AND NEWS

At the annual meeting of the Washington Academy of Sciences, the following officers for the year 1916 were elected: *President,* L. O. Howard; *Vice-presidents,* J. W. Fewkes, Anthropological Society; M. Carroll, Archeological Society; W. P. Hay, Biological Society; R. H. True, Botanical Society; R. B. Sosman, Chemical Society; J. C. Hoyt, Engineers Society; C. B. Mirick, Electrical Engineers Society; W. D. Hunter, Entomological Society; G. B. Sudworth, Foresters Society; O. H. Tittmann, Geographic Society; T. W. Vaughan, Geological Society; J. D. Morgan, Historical Society; E. Y. Davidson, Medical Society; L. J. Briggs, Philosophical Society; *Non-resident Vice-presidents,* E. C. Pickering, A. G. Mayer; *Corresponding Secretary,* F. E. Wright; *Recording Secretary,* W. J. Humphreys; *Treasurer,* W. Bowie; *Managers, Class of 1919,* G. K. Burgess and C. L. Alsberg.

Officers of the Royal Astronomical Society have been elected as follows: *President,* R. A. Sampson, astronomer royal for Scotland. *Vice-presidents,* Sir F. W. Dyson, astronomer royal; Colonel E. H. Hills, W. H. Maw, H. F. Newall, professor of astrophysics, Cambridge. *Treasurer,* E. B. Knobel. *Secretaries,* A. S. Eddington, Plumian professor of astronomy, Cambridge; Alfred Fowler, professor of astrophysics, Imperial College of Science and Technology. *Foreign Secretary,* Arthur Schuster. *Council,* Sydney Chapman; A. L. Cortie; A. C. D. Crommelin; J. W. L. Glashier; Walter Heath; J. H. Jeans; H. S. Jones; E. W. Maunder; J. W. Nicholson, professor of mathematics, King's College; T. E. R. Phillips; A. A. Rambaut, Radcliffe observer; H. H. Turner, Savilian professor of astronomy, Oxford.

The following officers of the Geological Society of London have been elected for the ensuing year: *President,* Dr. A. Harker; *Vice-presidents,* Sir T. H. Holland, Mr. E. T. Newton, the Rev. H. H. Winwood, and Dr. A. Smith Woodward; *Secretaries,* Mr. H. H. Thomas and Dr. H. Lapworth; *Foreign Secretary,* Sir Archibald Geikie; *Treas-*

urer, Mr. Bedford McNeill. In addition to these officers the members of the new council are: Mr. H. Bury, Professor J. Cadman, Professor C. G. Cullis, Mr. R. M. Deeley, Professor W. G. Fearnsides, Dr. W. Gibson, Dr. F. L. Kitchin, Dr. J. E. Marr, Mr. R. D. Oldham, Mr. R. H. Rastall, Professor T. F. Sibly, Professor W. J. Sollas, Dr. J. J. H. Teall and Mr. W. Whitaker.

THE Vienna School of Technology has conferred its honorary doctorate of engineering on Professor Alexander Bauer, formerly professor of chemistry there, who recently celebrated his eightieth birthday.

DR. R. WILLSTÄTTER, professor of chemistry at Berlin, has been elected a foreign member of the Swedish Academy of Sciences.

AT the conclusion of the present semester Dr. Hasse, professor of anatomy in Breslau since 1873, will retire from active service.

DR. ALONZO E. TAYLOR, Rush professor of physiological chemistry at the University of Pennsylvania, sailed on March 11 for Germany where he will engage in Red Cross work as an attaché of the American embassy at Berlin.

DR. JOSEPH A. BLAKE, formerly professor of surgery in Columbia University, has been made chief of the surgical center in the Department of the Seine and Oise, placing him in direct control of six military hospitals.

PROFESSOR ARTHUR G. MCCALL, of the Ohio State University department of agronomy, has resigned to take charge of the soil investigation work at the Maryland Agricultural Experiment Station, effective at the close of the academic year.

DR. H. E. EHLERS, professor of experimental engineering, in the University of Pennsylvania, has been appointed assistant chief of the bureau of engineering of the Pennsylvania Public Service Commission. During the remainder of this semester Dr. Ehlers will spend two days of each week at the university.

DR. LEONARD T. TROLAND, who received appointment at Harvard University to the Sheldon (non-resident) fellowship for the year 1915–16, is spending the year in Nela Research Laboratory. Mr. George P. Luckey, who has spent the past two years in graduate work at Göttingen University, has been appointed Charles F. Brush fellow in physics in Nela Research Laboratory for the year 1915–1916.

DR. J. D. FALCONER, lecturer in geography in Glasgow University and Swiney lecturer in geology at the British Museum, has been appointed temporary assistant district officer in the northern provinces of Nigeria.

PRESIDENT CHARLES R. VAN HISE, of the University of Wisconsin, lectured under the auspices of the Sigma Xi Society at the University of Minnesota on March 17. The subject of the lecture was "The Panama Canal, with Especial Reference to the Slides." President Van Hise is chairman of the commission appointed at the request of President Wilson by the National Academy of Arts and Sciences to investigate the slides, and has recently returned from a trip to Panama.

A MEETING of the Washington Academy of Sciences was held in the auditorium of the New National Museum on March 23, when Dr. L. H. Baekeland delivered an illustrated address entitled "Chemistry in Relation to the War."

AT the meeting of the Michigan Academy of Sciences this week, Professor Ernst A. Bessey, professor of botany at the Michigan Agricultural College, and president of the academy, gives an address on "The Sexual Cycle in Plants." Dr. Charles D. Davenport, director of the Station for Experimental Evolution of the Carnegie Institution, lectures on "The Relation of Juvenile Promise to Adult Performance."

A COURSE of eight lectures on "Problems and Methods in Dynamic Psychology," by Professor Raymond Dodge, is being given at Columbia University on Mondays and Tuesdays from March 27 to April 18.

BEFORE the department of geology of Columbia University a series of lectures on the "Nature and Bearings of Isostasy" is being de-

livered by Dr. Joseph Barrell, professor of structural geology in Yale University.

Dean Shenehan, of the College of Engineering of the University of Minnesota, lectured on March 20 and 21 to the engineering students of Purdue University.

Dr. Charles P. Steinmetz has completed arrangements with Provost Smith for the lecture course by professional engineers under the joint auspices of the Illuminating Engineering Society and of the university, to be held at the University of Pennsylvania in September, 1916.

The alumni of the Michigan College of Mines are raising an endowment fund for the college, to be known as the "George A. Koenig Memorial Fund." Dr. Koenig was from 1892 to 1914 professor of chemistry at the college.

Foreign papers announce the death of E. W. Pawlow, the Russian surgeon. It may be that the death of Ivan Pawlow, the physiologist of the St. Petersburg Academy of Sciences, cabled to this country and printed in Science, was an error due to confusion with E. W. Pawlow.

Charles Jeptha Hill Woodbury, a widely known engineer of Boston, died on March 20, aged sixty-four years.

John Wesley Judd, F.R.S., professor of geology from 1876 to 1905 and dean of the Royal College of Science, London, for the last ten years of that period, died on March 3, at the age of seventy-six years.

Dr. Ernst Mach, emeritus professor of the history and theory of inductive science at Vienna, has died at the age of seventy-eight years.

The deaths are also announced of Professor E. Heckel, professor of botany in the University of Marseilles; Professor Vladimir A. Tichomirov, professor of pharmacy and materia medica at Moscow University and Russian Councillor of State; and Dr. Fritz Schmid, since 1889 director of the Swiss Bureau of Health.

The Naples Table Association for Promoting Laboratory Research by Women announces an eighth prize of one thousand dollars for the best thesis written by a woman on a scientific subject. This thesis must embody new observations and new conclusions based on independent laboratory research in biological (including psychological), chemical, or physical science. The theses offered in competition must be in the hands of Dr. Lilian Welsh, Goucher College, Baltimore, Md., before February 25, 1917. The examiners are Dr. William H. Howell, Dr. Elmer P. Kohler and Dr. Henry Crew.

Professor Herbert Osborn, of Ohio State University, director of the Lake Laboratory, Cedar Point, Ohio, will be absent on leave next summer. The acting director will be Dr. F. H. Krecker, of the Ohio State University. Others on the staff will be Professor J. H. Schaffner, Ohio State; Professor S. R. Williams, Miami University; Professor Fullmer, Baldwin-Wallace, and Professor Z. P. Metcalf, of the North Carolina College. The laboratory will open on June 19. The course of instruction will continue until July 28 but the laboratory will be at the disposal of independent workers at least until the middle of August. The laboratory is well situated for the study of the fauna and flora of the Lake Erie region and any biologists interested will be welcomed.

We learn from *Nature* that the third Indian Science Congress met at Lucknow on January 13–15. About seventy papers were read and more than 300 visitors attended the meetings. The presidential address was delivered by Sir S. G. Burrard, F.R.S., who took as his subject "The Plains of Northern India, and their Relationship to the Himalaya Mountains." Sir A. G. Bourne, F.R.S., has been elected president for 1916–17, and the next meeting will probably be held at Bangalore.

A conference on Graduate Medical Education was held at the University of Minnesota on March 15, participated in by members of the graduate faculty at Minneapolis and those connected with the Mayo Foundation, Rochester, Minn. The program was as follows:

Afternoon Session

1. Address by President George E. Vincent.
2. Communication from Dean Guy Stanton Ford.

3. "General Requirement of the Graduate School," Dr. C. M. Jackson.

4. "The Thesis Requirement," Dr. J. B. Johnston; Dr. A. H. Logan.

5. "Methods of Graduate Instruction," Dr. E. P. Lyon.

Evening Session

6. Symposium on special requirements for the degree of doctor of science in various medical specialties (including desirable pre-requisites).

(*a*) "Medicine," Dr. L. G. Rowntree; Dr. H. S. Plummer.

(*b*) "Pediatrics," Dr. J. P. Sedgwick.

(*c*) "Surgery," Dr. J. E. Moore; Dr. E. M. Beckman.

(*d*) "Obstetrics," Dr. J. C. Litzenberg.

(*e*) "Eye, Ear, Nose and Throat," Dr. F. C. Todd; Dr. Carl Fisher.

(*f*) "Nervous and Mental Diseases," Dr. A. S. Hamilton.

(*g*) "Pathology and Bacteriology," Dr. L. B. Wilson; Dr. H. E. Robertson.

A stenographic record of the proceedings was kept and will perhaps be printed. If not, several copies will be available for the perusal of those interested in the development of graduate clinical instruction.

THE Forestry Club at the New York State College of Forestry at Syracuse University is giving for the season of 1915–16 the following lectures:

December 16—"The Story of the Forest," by Frederick E. Clements, chief, department of botany, University of Minnesota, and state botanist of Minnesota.

January 13—"The Development of a Forest Service for Minnesota," by William T. Cox, state forester of Minnesota.

January 18—"Close Utilization of the Products of the Forest," by W. R. Brown, of the Berlin Mills Co., Berlin, N. H.

January 27—"The Birth of a Forest Policy," by B. E. Fernow, dean, faculty of forest, University of Toronto, Toronto, Canada.

February 3—"Forestry and the Business Development of the Country," by Elmer E. Hole, editor, *American Lumberman*, Chicago, Ill.

February 17—"A Better Place to Live," by Frank A. Waugh, chief, department of horticulture, Massachusetts Agricultural College, Amherst, Mass.

February 24—"Forestry in New York," by James S. Whipple, former forest, fish and game commissioner of the state of New York, Salamanca, N. Y.

March 2—"The Vegetation of the United States as Influenced by Glacial Action," by Henry C. Cowles, of the University of Chicago.

March 9—"Modern Forest Utilization," by R. S. Kellogg, secretary, National Lumber Manufacturers Association, Chicago, Ill.

March 23—"State-wide Fire Protection for the Woodlots and Forests of New Hampshire," by E. C. Hirst, state forester of New Hampshire.

March 30—"Combating Insects of the Orchard and Forest in New York State," by George G. Atwood, chief, bureau of horticulture, New York State Department of Agriculture, Albany, N. Y.

April 6—"Shade-tree Work in Buffalo," by Harry B. Filer, city forester of Buffalo, N. Y.

THE following lectures are scheduled to be given before the Franklin Institute in Philadelphia:

March 23—"Recent Developments in Electrical Apparatus," by Harold Pender.

March 30—"Some Problems in Physical Metallurgy at the Bureau of Standards," by George K. Burgess.

April 6—"Use of Powdered Coal in Metallurgical Processes," by C. J. Gadd.

April 13—"Heat Measurements as Related to the Industries," by Charles W. Waidner.

April 19—"Scientific Research in Relation to the Industries," by Charles P. Steinmetz.

A BEQUEST of $25,000 has been made to the Cleveland Medical Library by the will of Dr. Benjamin L. Millikin, former dean and senior professor of ophthalmology of the Western Reserve Medical School.

UNIVERSITY AND EDUCATIONAL NEWS

THE wills of the late Edith and Walter Scull, niece and nephew of David Scull, for many years a manager of Haverford College, give $100,000 to the college.

THE trustees of Columbia University, at their last meeting, decided to admit women to the medical school as soon as the equipment made the step practicable.

AT Harvard University assistant professors have been appointed as follows: Grinnell

Jones, S.B. (Vanderbilt), chemistry; Elliott G. Brackett, M.D. (Harvard), orthopedic surgery, and Frederick H. Verhoeff, Ph.B. (Yale), ophthalmological research.

Dr. Otto Diels, of Berlin, has been called to the chair of chemistry at Kiel. Dr. R. Pohl, docent in Berlin, has been called to an associate professorship of physics at Göttingen.

DISCUSSION AND CORRESPONDENCE

DID SPENCER ANTICIPATE DARWIN?

In his book, entitled "The First Principles of Evolution," Mr. S. Herbert in speaking of Herbert Spencer says:

> Not only was he the first independently to adopt the evolutionary principle as a means of the solution of various problems of matter and mind, actually anticipating Darwin's discovery by a few years—a fact very little known by the general public—but he gradually elaborated a complete theory of evolution, comprising in one great formula the law of all existence.[1]

This statement, except the latter part of it, may hardly be said to be in conformity with the facts. When we remember the eminent services of Lamarck in the application of the evolutionary principle in his "Philosophie Zoologique" published in 1809, and subsequently (1815) in his "Histoire Naturelle des Animaux sans Vertèbres," it seems hardly fair to ascribe priority to Spencer in the adoption of the evolutionary principle, or even in adopting it "as a means for the solution of various problems of matter and mind"; and so far as Spencer anticipating Darwin is concerned, it is certainly incorrect, if by Darwin's discovery we understand, as most people do, the principle of natural selection.

It is true, of course, that as early as 1852, seven years prior to the publication of the "Origin of Species," Spencer presented with a clearness not since surpassed, the evolutionary hypothesis; and that in 1855 he published his "Psychology," which assumed the correctness of the broad evolutionary doctrine. But evolution and Darwin's discovery, as of course Mr. Herbert well knows, are quite different things.

In his autobiography, Vol. II., p. 56, Mr. Spencer says:

> Up to that time (1859) or rather up to the time in which the Linnean Society had become known to me, I held that the sole cause of organic evolution is the inheritance of functionally produced modification. "The Origin of Species" made it clear to me that I was wrong; and that the larger part of the facts can not be due to any such cause.

In an essay on "Transcendental Physiology," first published in 1857, Spencer used the following language:

> Various facts show that acquired peculiarities resulting from the adaptation of constitution to conditions, are transmissible to offspring. Such acquired peculiarities consist of differences of structure of composition in one or more of the tissues. This is to say, of the aggregate of similar organic units composing a germ, the group going to the formation of a particular tissue will take on the special character which the adaptation of that tissue to new circumstances had produced in the parents. We know this to be a general law of organic modifications. Further, it is the *only* law of organic modifications of which we have any evidence.[2]

Spencer himself instances this passage as showing the stage of his thought at that time concerning the factors of evolution. It will be observed that there is not the slightest hint of natural selection.

Again in his "Principles of Biology," Vol. I., p. 530, Mr. Spencer uses for the first time the phrase "survival of the fittest," as a substitute for "natural selection." In a footnote he explains why he sometimes uses the phrase "natural selection" after he had suggested the expression "survival of the fittest," and this expression had been approved by Wallace as a substitute for the other. He says:

> The disuse of Dr. Darwin's phrase would have seemed like an endeavor to keep out of sight my own indebtedness to him and the indebtedness of

[1] Herbert, S., "The First Principles of Evolution," p. 4, London, 1913.

[2] Spencer, H., "Essays," Vol. I., p. 91.

the world at large. The implied feeling led me ever since to use the expressions "natural selection" and "survival of the fittest" with something like equal frequency.

In the same volume, page 531, in referring to "natural selection," he says:

This more special mode of action Dr. Darwin has been the first to recognize as an all-important factor, though, besides his co-discoverer, Mr. A. R. Wallace, some others have perceived that such a factor is at work. To him we owe due appreciation of the fact that "natural selection" is capable of *producing* fitness between organisms and their circumstances.

Here we have "Darwin's discovery" specifically pointed out, and Spencer's acknowledgment of his own indebtedness.

Of course, it would have been no great matter even if the idea of natural selection had presented itself to Spencer before Darwin published the "Origin of Species" in 1859. Twenty years prior to that time it had suggested itself to Darwin and, being almost constantly at work on its application, he must have communicated the idea directly or indirectly to many of his friends. In fact he says in the short sketch of his life, prefixed to his "Life and Letters":

I tried once or twice to explain to able men what I meant by natural selection, but signally failed.

Possibly Spencer was one of these "able men."

Of course priority with respect to the idea of natural selection is of comparatively little importance. It flashed upon Darwin's mind, just as it did upon Wallace's, from reading a paragraph in "Malthus on Population." Darwin says:

In October, 1838, that is, fifteen months after I had begun my systematic enquiry, I happened to read for amusement "Malthus on Population," and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. The result of this would be the formation of a new species. Here then I had at last got a theory by which to work.

It was with both of these men an original idea, but it was foreshadowed by Aristotle, who, in his "Physicæ Auscultationes" (lib. 2, cap. 8, s. 2) said that:

Whatsoever, therefore, all things together (that is all the parts of one whole) happened like as if they were made for the sake of something, these were preserved, having been appropriately constituted by an internal spontaneity; and whatsoever things were not thus constituted; perished and still perish.

It was clearly recognized by Dr. W. C. Wells, in a paper read before the Royal Society in 1813 entitled: "An account of a white female, part of whose skin resembled that of a negro," and published in 1818. It was stated precisely by Mr. Patrick Mathew in 1831 in his work on "Naval Timber and Arboriculture." Everybody knows the story of how Darwin was "forestalled with a vengeance" by A. R. Wallace. It seems strange, then, that Spencer, who was writing more or less on biological subjects during the many years in which Darwin was at work on the idea of natural selection, does not appear to have gained even an inkling of the idea. He and Darwin were corresponding, and Darwin had complimented him on his admirable discussion of the development theory.

Perhaps the nearest approach of Spencer to the idea of natural selection occurs in an essay entitled "A Theory of Population Deduced from the General Law of Animal Fertility," published in 1852, although Spencer says he entertained as early as 1847, possibly earlier, the idea it embodies. In this essay, after declaring that the pressure of population has been the proximate cause of progress, Spencer goes on to say:

And here it must be remarked that the effect of pressure of population, in increasing the ability to maintain life, and decreasing the ability to multiply, is not a uniform effect, but an average one. . . . All mankind in turn subject themselves more or less to the discipline described; they either may or may not advance under it; but, in the nature of things, only those who do advance under it eventually survive. . . . For as those prematurely carried off must, in the average of cases, be those in whom the power of self-preser-

vation is the least, it unavoidably follows that those left behind to continue the race, are those in whom the power of self-preservation is the greatest—are the select of their generation.

Concerning this passage Spencer says in his "Autobiography," p. 451:

> It seems strange that, having long entertained a belief in the development of species through the operation of natural causes, I should have failed to see that the truth indicated in the above-quoted passages, must hold, not of mankind only, but of all animals; and must everywhere be working changes among them.

He attributes his blindness to his belief that the inheritance of functionally produced modifications suffice to explain evolution, and to the further fact that he knew little or nothing about the phenomena of variation.

The great merit of Darwin is, of course, not in originating the idea of natural selection, but in so presenting it to the world that it won acceptance. The fact that others anticipated him so far as the idea is concerned, does not, of course, detract from his merit. Wallace is entitled to much credit for the independent discovery of the idea and its clear presentation, but his anticipation was only in the disposition to proclaim the discovery. The foundation of Darwin's immortality is the book, "The Origin of Species." He was perhaps the only man in the world at the time who could have written that book. We might have attributed the possibility to Wallace, but with a self-abnegation perhaps unparalleled in the history of science, he said:

> I have felt all my life and I still feel, the most sincere satisfaction that Mr. Darwin had been at work long before me, and that it was not left for me to attempt to write "The Origin of Species." I have long since measured my own strength and know well that it would be quite unequal to that task. For abler men than myself may confess, that they have not that untiring patience in accumulating, and that wonderful skill in using, large masses of facts of the most varied kind, that wide and accurate physiological knowledge, that acuteness in devising and skill in carrying out experiments, and that admirable style of composition, at once clear, persuasive and judicial, qualities which in their harmonious combination mark out Mr. Darwin as the man, perhaps of all men now living, best fitted for the great work he has undertaken and accomplished.[3]

I. W. Howerth

University of California

THE ATOMIC WEIGHT OF RADIUM EMANATION (NITON)

In the International Atomic Weights Table for 1916,[1] the commission has adopted for radium the value of *226.0*, obtained by Hoenigschmid in 1911.[2] The atomic weight of radium emanation (niton), however, has been retained at its former value of *222.4* instead of substituting *222.0*, which would conform with the new value for radium. The probability of an oversight in publishing the table is perhaps eliminated by the appearance of the same value in the German report.[3]

The retention of the value *222.4* raises a question of considerable interest. The genetic relationship among elements, and the consequent interdependence of the atomic weights of radioactive elements is relatively new, and has as yet been given only indirect recognition in the atomic weight tables (see below). Of the 30-odd new radioactive elements, only radium and radium emanation have as yet been placed in the atomic weight table, since they are the only two which could as yet be obtained in sufficient quantity and purity for the application of ordinary methods of atomic weight determination.

Since no new experimental work has appeared on the atomic weight of niton, the retention of its old value until such work appears might be regarded *a priori* as justified. But it should be recalled that the experimental work of Gray and Ramsay,[4] on which the value *222.4* was based, in reality served only to demonstrate the order of magnitude of the atomic weight and would fit the value *222.0* equally as well as *222.4*. The latter

[3] "Contributions to the Theory of Natural Selection" (1871), preface, pp. iv, v.

[1] *Jour. Am. Chem. Soc.*, 37, p. 2,451.

[2] *Sitzb. Wien Akad.*, 120, p. 1,617; *ibid.*, 121, p. 1,973 (1912).

[3] *Zeit. phys. Chem.*, 90, p. 720.

[4] *Proc. Royal Soc.*, 84 *A*, p. 536.

value was chosen by Gray and Ramsay on purely genetic grounds, in accord with the then accepted value for radium of *226.4*. (The actual average of the experimental results of Gray and Ramsay was *223.0*.) The genetic principle once having been thus recognized in the atomic weight table, it would now appear requisite that the atomic weight of niton should be changed automatically to accord with that of radium. Of course from the standpoint of radioactivity the adoption of this change is automatic, but from the aforementioned considerations regarding the choice of Gray and Ramsay, there appears also no sufficient reason to retain the old value in the Atomic Weights Table.

S. C. LIND

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THE BRUCE MEDAL

THE notice of the award of the Bruce medal of the Astronomical Society of the Pacific, as recorded on page 285 of the February 25 issue, contains the first public statement that has come under my notice of the very ingenious method of award of this medal, "probably the most unique in the history of science."

The plan is due to the late Dr. Edward S. Holden, then director of the Lick Observatory, who secured the gift of the fund for this international medal. The plan he devised was designed to preserve the value of the medal as an international honor of high character, in spite of the fact that many of the directors of the society who would determine the awards would not be professional astronomers and often would not be capable of forming independent judgments as to the value to science of the distinguished services. In short, it was his purpose to make practically impossible an award to those who appear to be unable to keep their names out of prominent locations in the daily press. A glance at the list of recipients of the medal as published in your said notice shows how very successfully have worked out the plans thus contrived by him.

While the deliberations of the directors in making these awards are kept strictly confidential, a sidelight or two may be interesting. The rules provide that the six observatories named shall be invited to nominate not more than three men distinguished in astronomy. Ordinarily, this insures eighteen names, only one of which can receive the award; but in reaching the decision the directors often have been guided by the number of times the proposed recipient has been nominated. Occasionally, an elderly nominee, nearing the end of his activities, has been preferred over a younger man with the prospect of useful years ahead of him. It is worthy of note that the lists of every one of the six nominating observatories, for the first award of the medal, contained the name of Simon Newcomb.

One very well-known foreign observatory, however, added weight to its nominations in entirely different fashion. The first year it nominated Newcomb, Auwers and Gill, in the order named. Newcomb was the first medalist. The second year it nominated only Auwers and Gill. Auwers was the second recipient. The third year it nominated Gill alone, and Gill was the third. The fourth year it nominated three.

Only thirteen awards have been made in eighteen years because of the comparatively large sum spent out of the fund in the design and cutting of the dies. Designs were requested from experts both in this country and abroad, and the competition was arranged so that the name of the designer was unknown to the committee. When the designs were opened, although all were of high degree of excellence, one stood out in such contrast that only one choice was possible, and, with certain minor modifications, it was adopted. Alphée Dubois, of Paris, was the successful artist, and during his lifetime he personally engraved on the medals the names of the recipients, the dies being kept in the French Mint for this purpose.

This medal fund is only one of a number of such gifts of the late Miss Bruce, she having contributed frequently to the advancement of science.

ALLEN H. BABCOCK

A CHEAP ROCK POLISHING MACHINE

A small high-speed carborundum wheel, clamped to one of our work tables, has long been used for its obvious purposes. It may interest those geologists and paleontologists who have not stumbled on to the same fact to know that this machine offers a most efficient and rapid method of obtaining a polished section of a rock or a fossil. My attention was first called to this use of the machine during a conference with Mr. Robert Harvie on the organic identification of some obscure markings in a calcareous sandstone. By splitting the rock in an ordinary screw press and holding the desired portion of the exposed face against the side of the wheel, for which purpose there is a convenient rest, three flat sections were made and studied in as many minutes. The method is somewhat crude, but efficient, and may have wide application. A higher polish could be secured by using wheels of differing degrees of fineness.

Lancaster D. Burling
Geological Survey of Canada

THE SMITHSONIAN PHYSICAL TABLES

To the Editor of Science: The Smithsonian Institution has just published a new edition of the Smithsonian Physical Tables, corrected and slightly modified from the sixth revised edition. Requests have come from certain educational institutions for separate copies of certain individual tables for the use of students in laboratories. If there is likely to be a considerable demand for such separates, the institution will have them printed on stiff paper and distributed at cost to those who desire them. With a view to ascertaining the probable demand for separate tables, it is requested that readers of Science inform the institution which tables they would desire in separate form and the number of copies of each they would require. All tables for which the probable demand of this kind reaches 100 copies will be reprinted separately. The tables may be consulted in nearly all of the larger libraries.

C. D. Walcott,
Secretary

SCIENTIFIC BOOKS

Temperatur und Lebensvorgänge. Von Aristides Kanitz. Verlag von Gebrüder Borntraeger, Berlin. s.s. 175 mit 11 textfiguren. 1915.

"Temperatur und Lebensvorgänge" is the first of a series of biochemical mongraphs (Die Biochemie in Einzeldarstellungen), written by specialists, to be published by Gebrüder Borntraeger under the editorship of Aristides Kanitz. The series will treat of biological chemistry in its broadest sense and is comparable to the English monographs on Biochemistry edited by Plimmer and Hopkins.

It has been known for a long time that temperature has a very great influence on life processes, but only within recent years has a quantitative study been made and the values obtained compared with the effect of temperature on various physical and chemical processes. According to Kanitz the first quantitative studies were made by Clausens in 1890 on the carbon dioxide production of seedlings and the results interpreted by van't Hoff in terms of his rule—that the velocity of chemical reactions increases two- to three-fold for every ten degrees rise in temperature. Since that time many quantitative temperature investigations have been carried out with special reference to van't Hoff's rule or the RGT (Reaktionsgeschwindigkeit) rule as Kanitz prefers to call it. These investigations are systematically recorded in the book, which is unusually complete. Often the original data are given and always the value of Q_{10}, which indicates the rate of increase of any physiological process for a 10° C. rise of temperature. References are made to 363 original papers and the book contains both a subject and an author's index, besides a table of contents, so that any subject may be found with the greatest ease. The effect of temperature on various rhythmic processes, as heart beat, breathing, contractile vacuoles and contraction of medusæ; on the rate of the nerve impulse, muscle contraction, electromotive force of bioelectric currents, geotropic and phototropic reactions, protoplasmic streaming, permeability, effect of poisons, the length of life, rate of

growth, and various metabolic processes of plants and animals are all considered. Many observations are of the author's own work and all are discussed with reference to the RGT rule. Indeed, one wishes that the effect of temperature on purely physical processes was more fully considered. There is of course no doubt but that the main effect of temperature on life processes is to be explained in terms of its effect on chemical reactions, nevertheless, there are irregularities in the temperature coefficients of biological processes which must be explained as the result of temperature changing two processes at the same time, and not merely the velocity of some chain of chemical reactions. It is the exception rather than the rule which should now claim the attention of physiologists.

It is always a great convenience to have the results of some one subject of investigation collected and tabulated by a competent investigator and this book will serve as an excellent reference work to the physiologist and biochemist interested in temperature and as a guide to future research along that line.

E. NEWTON HARVEY
PHYSIOLOGICAL LABORATORY,
PRINCETON, N. J.

Geologia Elementar, preparada com referencia especial aos Estudantes Brasileiros e á Geologia do Brazil. Por JOHN C. BRANNER. Second edition, Francisco Alves et Cia, 166 Rua do Ouvidor, Rio de Janeiro, Brazil.

The second edition of this excellent handbook, not only for Brazilian students as the title states, but of Brazilian geology, brings up to date in 396 pages of text the matter presented in the first edition of the year 1906. Perhaps no one now living in or outside of Brazil is so well prepared to write a regional geology text of this character as President Branner. The present edition is based upon the first, which was written in English and translated into Portuguese with the collaboration of the late Dr. Derby. The additional matter in the new edition was written in Portuguese by the author, and revised by Doctors Barreto and Lisboa. The subject-matter is systematically set forth with illustrations of local geological peculiarities, among which the magnificent examples of weathered rocks, the coral banks of the coast and sandstone reefs of Pernambuco, the remarkable growths of the mangrove, the geological work of ants, and the striking evidences of a slightly elevated shore-line, form admirable subjects for didactic geology. Where Brazil is now wanting in evidences of important agencies of geological change, the author has very properly, in the interest of the student, introduced striking examples from foreign lands. The North American student of geology, even if he does not read Portuguese, will find the black-line maps illustrating the distribution of the geological formations of Brazil as they are at present known, the most serviceable at his command. The guide fossils representing the chief types in the Brazilian Upper Silurian, Devonian, Jurassic, Cretaceous and Tertiary deposits are set forth in line and stipple drawings which have the merit of distinctness. Numerous cross-sections show the understanding of the geological structure, in particular the coastwise portion of the country. President Branner has embodied the latest discoveries concerning the Permian glaciation in south Brazil, as well as the results of Dr. I. C. White's monographic work upon the "Geology of the Brazilian Coal Field." The footnotes give reference to the more important geological reports on the region, among which must not be forgotten the author's "Bibliography of the Geology of Brazil," in *Bulletin Geol. Soc. Amer.*, Vol. 20, p. 132, 1909.

The geological traveller bound to Brazil will find this work indispensable as a *vademecum*, and an additional incentive to gain command of the Portuguese tongue.

J. B. WOODWORTH

Irrigation in the United States. By RAY PALMER TEELE, M.A. D. Appleton and Company, 1915. Pp. 253.

The conquest by irrigation of the vast area of our country that lies under a low annual rainfall—approximately 20 inches and less—has become a matter of national interest. Our

increasing population needs the foodstuffs that may be produced, abundantly, on the irrigated farms, and the "landless" men want the new farms upon which to build independence for themselves and their families. During the last quarter of a century, public and private capital has been poured into the irrigation enterprises of the Great West; vast tracts have been opened for settlement; serious and difficult problems have arisen, which yet await solution. Thousands of investors, great and small, in all sections of the United States, are holding irrigation securities which in many cases are of doubtful value.

As the importance of land reclamation by irrigation became more fully realized, an irrigation literature of great value was produced, which, however, concerned itself chiefly with the construction of irrigation works, or with the actual use of water on the land. Mr. Teele, in the present volume, has had in mind the needs of the great body of our citizens, wherever they may live, who, because of their interest in irrigation, desire a comprehensive yet non-technical discussion of the meaning, extent, purpose, problems and present status of irrigation in the United States. The present volume is devoted, therefore, to a "discussion of the legal, economic and financial aspects" of irrigation.

The author has accomplished his purpose admirably. After a brief discussion of the irrigated section, with respect to climate, water supply and crops, the author takes up the consideration of legislation relating to irrigation, irrigation investments and the organization and operation of irrigation enterprises. This discussion, though brief, is exceedingly clear and comprehensive, and the reader is left with a vivid picture of the real irrigation situation in our country. Elements of weakness or strength are pointed out and wise suggestions are frequently made for improvement. To the seasoned student of irrigation, the last chapter, on the present situation and future of irrigation in the United States, is of greatest interest, for it includes the author's well-reasoned conclusions concerning the methods of stabilizing the economics of irrigation.

The book should be read and studied by national and state legislators, who have to do with the making of irrigation laws; by the projector of new irrigation enterprises; by the investor; by the man on the irrigated farm, and by all who are interested in the gigantic movement to conquer all of our Great West for the use of man.

Mr. Teele is particularly well fitted to speak with authority on irrigation subjects. Through his editorial hands have passed practically every irrigation publication issued by the U. S. Department of Agriculture since 1899. He is personally familiar with the irrigated section, and is an enthusiastic believer in irrigation, though he has never closed his eyes to its difficulties. Irrigation in its present stage of development needs honest friends.

The survey in this volume is so brief that we hope the author may some time find time to enlarge upon his theme for the technical student. Moreover, we shall not know the full meaning of irrigation until its sociological aspects are examined, and this volume only hints at the conditions of human life under the ditch. Nevertheless, Mr. Teele's book is a great contribution to irrigation advancement in that it brings order out of a confusion of knowledge, and points out the way by which our present irrigation difficulties may be overcome.

John A. Widtsoe
Utah Agricultural College,
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SPECIAL ARTICLES

ON THE PHYSICAL CHEMISTRY OF EMULSIONS AND ITS BEARING UPON PHYSIOLOGICAL AND PATHOLOGICAL PROBLEMS

I

We have been engaged during the past few months in a study of the conditions which determine the making and the breaking of emulsions. In addition to verifying certain well-known observations, this inquiry has brought some new points of view which are of importance for the theory of the stability of emulsions, and for the solution of such technical and biological problems as are embraced in the making of butter, the preparation of thera-

peutic emulsions, fatty degeneration, the formation of fatty secretions, etc.

Of the long list of mutually immiscible liquids that might have been chosen for a study of emulsification, we have worked chiefly with water and oil. The mixture of two such immiscible liquids may yield two types of emulsions, as Walther Ostwald first showed; one consisting of oil in water, a second, of water in oil. With much water and little oil, the first type of emulsion is usually obtained; with much oil and little water, the second type. When medium amounts of the two liquids are mixed with each other, either type may be produced, depending upon the methods of mixing.

Oil placed in contact with water does not lead spontaneously to the formation of an emulsion. To produce such, the two must be beaten together. The amount of oil that may be emulsified in pure water is very small, in no case exceeding one or two per cent. These emulsions are, however, stabile. The oil particles in such emulsions are rather small, their dimensions lying within the realm of the colloids. These low concentrations of oil in water, therefore, really represent colloid suspensions of oil in water and possess not only the stability characteristics of such systems, but also their well-known "saturation limit."

The term "emulsion" is ordinarily used to cover the subdivision of one fluid in a second in amounts exceeding these low values. The mixture must, moreover, show a fair degree of stability; in other words, the two liquids constituting the dispersoid must not separate in the course of weeks, months or years. A *temporary* subdivision of any quantity of oil in a given volume of water, or the converse, can, of course, be obtained by merely beating the two together.

The problem of emulsification therefore resolves itself into the question of how, once the division of oil in water has been accomplished, this can be, or is, stabilized. Contrary to the general belief of different workers who have each tried to discover some *one* element as responsible for this stabilization, a number of different factors evidently play a rôle, the relative importance of which may not only vary in different emulsions, but in the same emulsion under different circumstances.

It is generally held that the formation and the maintenance of an emulsion depend upon the slight surface tension of the dispersing medium, and its high viscosity. While both these factors undoubtedly play a part, their inadequacy in explaining the stability of all emulsions is generally admitted. Not only does the stability of emulsions not universally parallel the surface tension values of the liquids making up a given dispersoid, but dilute soap solutions with low viscosity act as better emulsifying agents than more viscid glycerin solutions. Pickering has emphasized the importance of a third factor in the maintenance of an emulsion, namely, the development of an encircling film about the droplets of the divided phase through the accumulation in the surface between oil and dispersion medium, of finely divided particles of a third substance. But this explanation, too, seems adequate only for selected examples of emulsions.

II

In reviewing the empirical instructions available for the preparation of emulsions, and in our own attempts to formulate such as would always yield permanent results, we were struck with the fact that their production is always associated with the discovery of a method whereby *the water (or other medium) which is to act as the dispersing agent is all used in the formation of a colloid hydration (solvation) compound.* In other words, when it is said that the addition of soap favors the formation and stabilization of a division of oil in water, it really means that soap is a hydrophilic colloid which, with water, forms a colloid hydrate with certain physical characteristics, and that the oil is divided in this. *The resulting mixture can not, therefore, be looked upon as a subdivision of oil in water, but rather as one of oil in a hydrated colloid.*

The amount of colloid necessary for stabilization, at least in the preparation of an emulsion, is rather great. It must be sufficient to

bind all the water. The concentrated soaps show a high degree of water-absorbing power and so are among the best emulsifying agents. Very good, too, are blood-albumin, casein, egg-white and egg-yolk, this last already representing an emulsion of oil in a hydrated protein. Good emulsions may also be prepared with aleuronat, and, when the temperature is properly controlled, with gelatin. Not only may proteins be thus used, but various hydratable carbohydrates do well. Acacia has long been so used. Starch, dextrin (or the dextrinized starches used in baby foods), and, when the temperature is properly regulated, agar, also serve well. Oil can also be maintained in finely subdivided form in cane sugar solutions or glycerin, but these emulsions slowly separate.

The enumerated substances do not all act equally well. This is because, in the production of a hydrated colloid, they behave differently from both a qualitative and quantitative viewpoint. Best results are obtained with those substances which not only have the power of taking up much water, but which yield liquids of good viscosity with all amounts of water that may be added to them. What is wanted is a relatively homogeneous liquid of good tenacity, by which is meant one that possesses good covering power together with great cohesiveness.

The action of casein as a stabilizing agent is particularly instructive. Neutral casein does not absorb much water and it does not in this form serve for the preparation of an emulsion. But when alkali is added, it develops marked hydrophilic properties, on the appearance of which it becomes one of the best stabilizing agents for emulsions known. It might be thought that the alkali element is so important because it forms a soap in contact with oil, and soap has long been known as an effective emulsifier. While some such action no doubt occurs, it is easily proved that the development of hydrophilic properties by the casein is of first importance because acid (which when added to neutral casein converts it into a hydrophilic colloid) works quite as effectively as does alkali.

III

An emulsion breaks whenever the hydrophilic (lyophilic) colloid which holds the aqueous dispersion means is either diluted beyond the point at which it can take up all the offered water, or is so influenced by external conditions that its original capacity for holding water is sufficiently reduced.

Certain emulsions, as those of oil in soap, therefore, tend to break on simple dilution. But agents which dehydrate the hydrophilic colloid act even more rapidly and effectively. What will prove to be effective agents in this regard depends, of course, upon the character of the hydrophilic colloid stabilizing the emulsion. When alkali-casein is used, the addition of acid breaks the emulsion, while alkali will break an emulsion stabilized by acid-casein. The same concentration of acid or alkali is without effect upon an emulsion stabilized by a carbohydrate like acacia, or dextrin. Since even neutral salts will dehydrate an acid- or alkali-protein, they readily serve to break emulsions stabilized by these substances. An emulsion of oil stabilized in soap is readily broken not only by acids and various salts, but also by alcohol. Ether, on the other hand, is relatively ineffective. Practically all these substances in low concentrations are without effect upon emulsions stabilized in hydrated carbohydrates.

The fact that alcohol and ether are by themselves thus relatively ineffective in breaking emulsions explains why the ordinary fat extraction methods are so often only partially effective in getting the fat out of biological materials, and why previous treatment of the material, as by digestion with strong acids or alkalies and by similar methods, yields higher fat figures than extraction with ether or allied materials alone.

IV

The problem of the distribution of fat in living cells or in various secretions from the living tissues may be separated into two divisions; first, a chemical one dealing with such questions as that of the origin and transport of fat, and second, a physical one asking, for

example, how smaller or larger amounts of fat may be stored in cells without at one time being visible or demonstrable by micro-chemical methods, while at another, as in "fatty degeneration," they are.

There is scarcely a tissue or fluid of the body which even in the poorest states of nutrition, does not contain some fat. But even the smallest amounts of fat thus found exceed the quantities that can be dispersed in permanent form in pure water. The presence of such amounts of fat in these structures, therefore, at once presents a problem identical with that which asks how it is possible, outside of the body, to maintain a fat in finely divided form in an aqueous dispersion means. *The presence of any amount of fat in a cell or tissue exceeding a fraction of one per cent. is possible only because the tissues contain hydrophilic colloids.*

Looked at from another point of view, even the smallest amounts of fat ever found in cells suffice to prove that *the cell contents are not mere aqueous solutions of various salts and non-electrolytes contained in a semi-permeable bag,* as is so generally believed by the adherents of the osmotic conception of cell constitution.

How completely the notion that our cells are filled with salt solutions must go to pieces, becomes clearly evident when it is recalled that certain of our cells and tissues contain even normally some twenty-five per cent. of fat and fat-like bodies. Thus, of a hundred grams of nerve tissue, seventy grams are water, and over twenty grams are fat. The remainder is protein chiefly. *Nerve tissue and all tissues which, under normal or abnormal circumstances, hold such large quantities of fat are able to do so only because this material is stabilized in a finely divided state through the presence of hydrophilic colloids (like proteins and soap) which hold the water of the cells as a hydration compound.*

While the fat in the cells of the body is not ordinarily visible in the state in which it exists here normally, certain pathological conditions popularly termed "fatty infiltration" or "fatty degeneration" suffice to make the fat readily visible. The older pathologists believed that more fat was thus visible for the reason that the cells had come to contain more (either because this had been brought to, or stored in the cells) or because their protein had been changed to fat. Modern studies of the question have proved the last of these possibilities to be entirely without foundation, so that now both "fatty infiltration" and "fatty degeneration" are at the worst held to be nothing more than states in which an excessive deposition may occur. But quantitative chemical studies have come to show that even the worst types of fatty degeneration in tissues may yield no fat figures lying beyond the amounts commonly found in these same localities under physiological conditions. In the majority of instances chemical analysis fails to show that the affected cells contain any more than their normal fat content. *In essence, therefore, "fatty degeneration" no longer represents a chemical, but a physical problem, which asks how a given quantity of fat usually so distributed in a cell as to be invisible, becomes re-distributed in such fashion as to be readily visible.*

We believe this problem is identical with that which asks how an emulsion of oil in protein or soap (so fine that the individual oil droplets can not be made out as more than granules even with high microscopic magnification) can be broken to the point where the fat granules will coalesce to form more readily visible droplets. As a matter of fact, detailed study of the conditions which are necessary for the production of typical "fatty degeneration" in tissues shows these to be identical with those which lead to the breaking of emulsions of the type of oil in alkali-casein, oil in soap, etc.

The various substances generally listed as capable of producing a "fatty degeneration" (phosphorus, lead, arsenic, mercury, alcohol, ether, chloroform, diabetes, local circulatory disturbances, intoxication with acids, etc.) are all of them means by which the normal hydration capacity of the soaps or of certain of the proteins of the cell (as the globulins) is markedly decreased. The matter is best illus-

trated, perhaps, by detailing a specific instance.

When a cell, in consequence of injury, is made the subject of an acid intoxication by any of the direct or indirect means enumerated in the last paragraph, the acid makes some of the proteins of the affected cells swell, while another group (the globulins) is dehydrated and precipitated. The combination of swelling with precipitation yields what the pathologists call "cloudy swelling." But as the pathologists have long noted, a persistence of cloudy swelling is followed, almost as a rule, by a "fatty degeneration" of the affected cells. On the basis of our remarks this coalescence of the oil droplets into the larger visible ones of "fatty degeneration" is dependent upon the removal, through the action of the acid, of some of the stabilizing effects of the proteins, soaps and other hydrophilic colloids contained in the cells. The increased swelling represents a dilution of the hydrophilic colloids of the cell, while the clouding represents a dehydration of certain others.

These studies on emulsions contribute toward the explanation of yet another pathological observation. When any tissue, as a portion of the brain, through some such pathological disturbance as a thrombosis is deprived of its normal blood supply, the affected member shows first a cloudy swelling accompanied or succeeded by a "fatty degeneration," and then a "softening" of the tissues. How at least a portion of this (and we are inclined to think the major portion in such tissues as the brain) is brought about is illustrated in the changes in viscosity observable in the preparation of an emulsion or its subsequent destruction. Seven per cent. potassium soap and cottonseed oil, for instance, are both relatively mobile liquids, but when mixed in proper proportion they yield an emulsion so stiff that it will stand alone. This is the analogue of the twenty-five per cent. emulsion of fat and lipoid in hydrated protein which we call the brain. If the oil-in-soap emulsion is broken through the addition of a little acid it yields an impure mixture of oil, water and precipitated colloid material—the analogue of the liquid contents found in any area of brain "softening."

Application may also be made of these studies to the problem of the giving off of such essentially fatty secretions as make up ear wax, vernix caseosa, sebum, the fatty secretions of plants, etc. *These all represent a transition from the normal type of oil in hydrophilic colloid emulsion to that of hydrophilic colloid in oil emulsion.* A homely analogue of this type of change is seen in butter-making, which consists of changing cream (essentially an emulsion of oil in hydrophilic colloid) into butter (a fat into which are divided about fourteen per cent. of water). Similarly, the essentially fatty secretions from the body as well as the fat contained in the adipose tissues of the body, all prove to be fats containing some seven to fifteen per cent. of water emulsified in them.

The details of these observations will be published in the *Kolloid-Zeitschrift.*

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Gravitation and Electrical Action[1]

In former publications the present writer has suggested that there is an intimate relation between gravitation and electrical action at a distance, or what has been called statical effects. There can be no doubt of the truth of the statement that the attraction between two masses of matter depends not only upon the amount of matter in the two masses, and their distance from each other, but also upon their electrical potential.

The gravitation constant has been determined by finding the attraction between two spheres of metal. In these determinations the electrical potential of the masses has been ignored. It has been assumed that there are no electrical charges on the two masses, if their potential is that of the earth.

Assume that two spheres, having radii R_1 and R_2 composed of metal having a density ρ,

[1] Extract from a forthcoming number of the *Transactions of the Academy of Science of St. Louis.*

and distant from each other r, have charges Q_1 and Q_2, the spheres having a common potential V. Their attraction for each other will be

$$A = K\frac{m_1 m_2}{r^2} - \frac{Q_1 Q_2}{r^2}$$

$$= K\frac{16}{9}\frac{\pi^2 R_1^3 R_2^3 \rho^2}{r^2} - \frac{R_1 R_2}{r^2} V^2$$

Here K is the value of Newton's constant of gravitation, as it would be determined by the method of Cavendish or Boys, if V were zero absolute.

If V is not zero, and the second term is omitted, the last equation might be written

$$A = K\left(1 - \frac{x}{100}\right)\frac{16}{9}\frac{\pi^2 R_1^3 R_2^3 \rho^2}{r^2}$$

In this equation $K[1-(x/)100)]$ is the gravitation constant that would be determined under such conditions. Both K and x would remain unknown quantities.

Equating these two values of A

$$V = \tfrac{4}{3}\pi R_1 R_2 \rho \frac{\sqrt{Kx}}{10}$$

If V is measured in volts

$$V = 40\pi R_1 R_2 \rho \sqrt{Kx}$$

If $R_1 = 10$, $R_2 = 1$, $\rho = 11.35$ and $K = 6.6576 \times 10^{-8}$

$$V = 3.68\sqrt{x}$$

This result shows that if these two spheres have a common potential which differs from absolute zero by 3.68 volts, the value of K as determined by the Cavendish method will be in error by one per cent. of the above value which is that of Boys. If V were $\pm$ 8.23 volts, an error of five per cent. would result. If V were 36.8 volts the two spheres would cease to attract each other. The absolute zero in V would be the common potential of the two bodies, when their attraction for each other is a maximum.

Storm clouds and the electrified atmosphere are continually acting inductively upon the earth's surface. The potential difference at the ends of a flash of lightning may amount to thousands of millions of volts. Aside from such disturbances, we are wholly in the dark concerning the average potential of the earth.

It is evident that the smaller the masses used in such determinations, the greater will be the possibility of error in the result, when the potential term is ignored.

It seems very probable that we do not know the real value of the gravitation constant.

FRANCIS E. NIPHER

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and eighty-second regular meeting of the society was held at Columbia University on Saturday, February 26, extending through the usual morning and afternoon sessions. The attendance included forty-three members.

The president of the society, Professor E. W. Brown, of Yale University, occupied the chair, being relieved by Professors H. B. Fine, T. S. Fiske and H. S. White. The following persons were elected to membership: Mr. L. E. Armstrong, Stevens Institute of Technology; Professor Grace M. Bareis, Ohio State University; Professor G. A. Chaney, Iowa State College; Mr. J. E. Davis, Pennsylvania State College; G. H. Hardy, M.A., Trinity College, Cambridge, England; Mr. Harry Langman, Metropolitan Life Insurance Company, New York City; Mr. E. D. Meacham, University of Oklahoma; Dr. A. L. Nelson, University of Michigan; Mr. Elmer Schuyler, Bay Ridge High School, Brooklyn, N. Y. Six applications for membership were received.

The society has recently taken over the stock of the Chicago Papers and Boston Colloquium Lectures, heretofore in the hands of The Macmillan Company. All publications of the society, so far as in stock, are now obtainable directly from the main office. The New Haven Colloquium was published by the Yale University Press, and is sold by them.

The List of Members of the society for 1916 has just been issued. Copies may be obtained from the secretary.

The following papers were read at this meeting:

T. H. Gronwall: "A functional equation in the kinetic theory of gases (second paper)."

T. H. Gronwall: "On the zeros of the functions $P(z)$ and $Q(z)$ associated with the gamma function."

T. H. Gronwall: "On the distortion in conformal representation."

C. A. Fischer: "Equations involving the derivatives of a function of a surface."

E. W. Brown: "Note on the problem of three bodies."

H. Bateman: "A certain system of linear partial differential equations."

H. Bateman: "On multiple electromagnetic fields."

A. R. Schweitzer: "On a new representation of a finite group."

A. R. Schweitzer: "Definition of new categories of functional equations."

E. B. Wilson: "Critical speeds for flat disks in a normal wind theory."

E. B. Wilson: "A mathematical table that contains chiefly zeros."

E. B. Wilson: "Changing surface to volume integrals."

T. H. Gronwall: "Elastic stresses in an infinite solid with a spherical cavity."

T. H. Gronwall: "On the influence of keyways on a stress distribution in cylindrical shafts."

O. E. Glenn: "The formal modular invariant theory of binary quantics."

O. E. Glenn: "The concomitant system of a conic and a bilinear connex."

P. R. Rider: "Trigonometric functions for extremal triangles."

H. S. Vandiver: "Symmetric functions of systems of elements in a finite algebra and their connection with Fermat's quotient and Bernoulli's numbers (second paper)."

S. A. Joffe: "Calculation of eulerian numbers from central differences of zero."

The next meeting of the society will be held at Columbia University on April 29. The Chicago Section will meet at the University of Chicago on April 21–22. The summer meeting of the society will be held this year at Harvard University early in September. At the eighth colloquium of the society, held in connection with the summer meeting, courses of lectures will be given by Professors G. C. Evans, of Rice Institute, on "Topics from the theory and applications of functionals, including integral equations," and by Professor Oswald Veblen, of Princeton University, on "Analysis situs."

F. N. Cole,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 551st regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, February 26, 1916, called to order at 8 P.M. by President Hay. Fifty persons were present.

The first paper on the program was by D. E. Lantz, "An Early Seventeenth Century Mammalogist." This was a review of Edward Topsell's "History of Foure-footed Beastes," published in London in 1607. Topsell was born about 1538 and at the completion of this, the first general work on mammals published in the English language, was chaplain of the church of St. Botolph, Aldergate, under Richard Neile, Dean of Westminster, to whom the book is dedicated. The work, including illustrations, is largely translated from Conrad Gesner's "Historia Animalium," published in 1551; but the author quotes also from over 250 other writers, Hebrew, Greek, Latin, German, Italian and French authorities, and including 76 medical treatises. The speaker gave many curious extracts from Topsell illustrating them with lantern pictures of the animals under discussion, taken from the old wood cuts in the book. The pictures included the antelope, an ape monster, the American sloth, the beaver, various kinds of hyenas, the unicorn, the riverhorse and the Su, an untamable and ferocious animal that has been identified with the American opossum.

The second and last paper on the program was by J. W. Gidley, "A Talk on the Extinct Animal Life of North America." Mr. Gidley defined the terms fossil, petrifaction, explained how fossils were formed under various conditions and how they are discovered by the collector. He discussed the evolution of certain animals as shown by their fossil remains as particularly exemplified by horses, elephants and dinosaurs. He emphasized in especial the unfortunate tendency on the part of paleontologists to try to see in fossil remains ancestral forms of later fossils or of existing animals. The speaker thought that many fossils represented highly specialized types of their kind, some extinct animals being more highly specialized than their present-day representatives, in fact in many cases their extreme specialization has led to their extinction. In a general way fossil forms represent the evolution of certain groups but the immediate connecting forms are for the most part lacking. Mr. Gidley's communication was profusely illustrated with lantern views of fossil-bearing localities, of fossils, and of certain artists' restorations of fossils. Mr. Gidley's communication was discussed by Dr. L. O. Howard.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

FRIDAY, APRIL 7, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE DISTANCES OF THE HEAVENLY BODIES[1]

A YEAR ago our retiring president took the members of the society into his confidence as follows:

> Cognizant of the fact that my election to the presidency of the Philosophical Society a year ago obligated me to give an address of some sort one year later, I confidently waited for the inspiration that I felt would suggest a fitting subject for the occasion. The expected inspiration did not, however, materialize.

Undoubtedly because of that fact, and out of the goodness of his heart, towards the close of his address he turned to the present speaker, then presiding, and said:

> I have said nothing whatever about the determination of the distances between the planets nor of the units used by astronomers in reckoning distances of the stars. . . . They form, so to speak, other chapters of the subject which I shall leave to some future ex-president of our society.

This call, I suppose, was intended to take the place of an inspiration, and, wherever I have gone during the past twelve months the call has ever been ringing in my ears. The subject of the evening is presented therefore not as a matter of choice, but from compulsion.

Before any attempt was made by the ancients to determine the distance from the earth of any celestial body, we find them arranging these bodies in order of distance very much as we know them to-day, assuming that the more rapid the motion of a body among the stars the less its distance from the earth; the stars, that were supposed to have no relative motions, were assumed to be the most distant objects.

[1] Address of the president of the Philosophical Society of Washington, March 4, 1916.

The first attempt to assign definite relative distances to any two of the bodies was probably that of Eudoxus of Cnidus who, about 370 B.C., supposed, according to Archimedes, that the diameter of the sun was nine times greater than that of the moon, which is equivalent to saying, since the sun and the moon have approximately the same apparent diameter, that the distance of the sun from the earth is nine times greater than that of the moon.

A century later, about 275 B.C., Aristarchus of Samos gave a method of determining the relative distances of the sun and moon from the earth as follows: When the moon is at the phase, first quarter or last quarter, the earth is in the plane of the circle which separates the portion of the moon illuminated by the sun from the non-illuminated part, and the line from the observer to the center of the moon is perpendicular to the line from the center of the moon to the sun. (Diagram shown.) If, at this instant, the angular separation of the sun and moon is determined, one of the acute angles of a right-angle triangle—sun, moon and earth—is known, from which can be deduced the ratio of any two of the sides, as, for instance, the ratio of the distance from the earth to the moon to that from the earth to the sun. Aristarchus gives the value of this angle as differing from a right angle by only one thirtieth of that angle, *i. e.*, it is an angle of 87°, from which follows that the distance from the earth to the sun is nineteen times that from the earth to the moon. This method of Aristarchus is theoretically correct, but, in determining the angle at the earth as being 3° less than a right angle, he made an error of about 2° 50′.

Hipparchus, who lived about 150 B.C. and was called by Delambre the true father of astronomy, attacked the problem of the distances of the sun and moon through a study of eclipses. Assuming in accordance with the result of Aristarchus that the sun is nineteen times as far from the earth as the moon, having determined the diameter of the earth's shadow at the distance of the moon and knowing the angular diameter of the moon, he found 3′ as the sun's horizontal parallax. By the sun's parallax is meant the angle at the sun subtended by the earth's semi-diameter and if a = the semi-diameter of the earth, Δ = the distance to the sun, and π = sun's horizontal parallax, the relation between these quantities is expressed by the equation (diagram shown).

$$\text{Sin } \pi = a/\Delta.$$

The next attempt to determine the distance of a heavenly body was made about A.D. 150 by Claudius Ptolemy, the last of the ancient astronomers, and one whose writings were considered the standard in things astronomical for fifteen centuries. To determine the lunar parallax, he resorted to direct observations of the zenith distance of the moon on the meridian, comparing the result of his observations with the position obtained from the lunar theory. He determined the parallax when the moon was nearest the zenith, and also when it crossed his meridian at its farthest distance from the zenith. From his observations he obtained results varying from less than 50 per cent. of the true parallax (57′.0) to more than 150 per cent. of that value. According to Houzeau the definitive result of Ptolemy's work is 58.′7.

It is thus seen that the astronomers of two thousand years ago had a fairly accurate knowledge of the distance of the moon from the earth, but an entirely erroneous one of the distance of the sun, the true distance being something like twenty times that assumed by them. This value of the distance of the sun from the earth was accepted for nineteen centuries, from Aristarchus to Kepler, having been deduced

anew by such men as Copernicus and Tycho Brahe.

With the announcement by Kepler, early in the seventeenth century, of his laws of planetary motion, it became possible to deduce from the periodic times of revolution of the planets around the sun their relative distances from that body, and thus to determine the distance of the sun from the earth, by determining the distance or parallax of one of the planets.

From observations of Mars, Kepler obtained the distance of the sun from the earth as about three times that accepted up to his time. His value, however, was but one seventh of the true distance. About fifty years later Flamsteed and Cassini working independently, and using the same method as that employed by Kepler, obtained for the first time approximately the correct value of the distance of the sun from the earth. In a letter, dated November 16, 1672, to the publisher of the *Philosophical Transactions,* Flamsteed says:

> September last I went to Townley. The first week that I intended to have observed ♂ there with Mr. Townley, I twice observ'd him, but could not make two Observations, as I intended, in one night. The first night after my return, I had the good hap to measure his distances from two Stars the same night; whereby I find, that the Parallax was very small; certainly not 30 seconds: So that I believe the Sun's Parallax is not more than 10 seconds. Of this Observation I intend to write a small Tract, when I shall gain leisure; in which I shall demonstrate both the Diameter and Distances of all the Planets by Observations; for which I am now pretty well fitted.

During the two and a half centuries since Flamsteed's determination there have been more than a hundred determinations of the solar parallax by various methods. In the method used by Flamsteed, the rotation of the earth is depended upon to change the relative position of the observer, the center of the earth, and Mars. (Diagram shown.) Another method is to establish two stations widely separated in latitude, and in approximately the same longitude. At one station, the zenith distance of Mars will be determined as it crosses the meridian north of the zenith; at the other station, the zenith distance will be determined as it crosses the meridian south of the zenith. The sum of the two zenith distances minus the difference in latitude between the two stations will give the displacement of Mars due to parallax. These two methods have been successfully applied to several of the asteroids whose distances from the sun are very near that of Mars.

The nearest approach of Venus to the earth is during her transit across the face of the sun, and these occasions, four during the last two centuries, have been utilized to determine the solar parallax. Here as in the case of Mars two different methods may be used, either by combining observations at two stations widely separated in latitude, or at two stations widely separated in longitude. (Diagrams shown.)

The methods just described for obtaining the solar parallax, the geometrical methods, were made available, as has been said, by the discovery of Kepler's laws of planetary motion. Newton's discovery of the law of gravitation gave rise to another group of methods, designated as gravitational methods. The best of these is probably that in which the distance of the sun from the earth is determined from the mass of the earth, which, in turn, is determined from the perturbative effect of the earth upon Venus and Mars. This method is long and laborious, but its importance lies in the fact that the accuracy of the result increases with the time. Professor C. A. Young says:

> This is the "method of the future," and two or three hundred years hence will have superseded all the others—unless indeed it should appear that bodies at present unknown are interfering with the movements of our neighboring planets, or un-

less it should turn out that the law of gravitation is not quite so simple as it is now supposed to be.

A third group of methods of determining the distance of the sun from the earth, called the physical methods, depends upon the determination of the velocity of light in conjunction either with the time it takes light to travel from the sun to the earth obtained from observations of the eclipses of Jupiter's satellites, or with the constant of aberration derived from observations of the stars.

In August, 1898, Dr. Witt, of Berlin, discovered an asteroid, since named Eros, which was soon seen to offer exceptional opportunity for the determination of the solar parallax, as at the very next opposition, in November, 1900, it would approach to within 30,000,000 miles of the earth. At the meeting of the Astrographic Chart Congress in Paris in July, 1900, it was resolved to seize this opportunity and organize an international parallax campaign. Fifty-eight observatories took part in the various observations called for by the general plan. The meridian instruments determined the absolute position of Eros from night to night as it crossed the meridians of the various observatories; the large visual refractors measured the distance of Eros from the faint stars near it, at times continuing the measures throughout the entire night; and the photographic equatorials obtained permanent records of the position of Eros among the surrounding stars. In addition long series of observations had to be made to determine the positions of the stars to which Eros was referred.

When several years had elapsed after the completion of the observations, and no general discussion of all the material had been provided for, Professor Arthur R. Hinks, of Cambridge, England, volunteered for the work. The undertaking was truly monumental. He first formed a catalogue of the 671 stars which had been selected by the Paris Congress for observation as marking out the path of Eros from a discussion of the results obtained by the meridian instruments and from the photographic plates. This done, with these results as a basis, a larger catalogue of about 6,000 stars had to be formed from measures on the photographic plates. He was then ready to commence the discussion of the observations of Eros itself. From 1901 to 1910 there appeared in the *Monthly Notices* of the Royal Astronomical Society eight articles covering 135 pages giving the results of his labors.

From a discussion of all the photographic observations he obtained a solar parallax of $8''.807 \pm 0''.0027$, a probable error equivalent to an uncertainty of about 30,000 miles in the distance to the sun.

From a discussion of all the micrometric observations he obtained $8''.806 \pm 0''.004$.

The observations with the meridian instruments gave $8''.837 \pm 0''.0185$, a determination relatively much weaker than either of the others.

A parallax of $8''.80$, the value adopted for all the national almanacs twenty years ago, corresponds to a distance of 92,900,000 miles. At present it seems improbable that another parallax campaign will be undertaken before 1931, when Eros approaches still nearer to the earth, its least distance at that time being about 15,000,000 miles.

APPROXIMATE DISTANCES FROM EARTH TO SUN AS ACCEPTED AT VARIOUS TIMES

Date.	Distance, Miles.
275 B.C. to A.D. 1620	4,500,000
1620 Kepler	13,500,000
1672 Flamsteed	81,500,000
1916	92,900,000

When Copernicus proposed that the sun is the center of the solar system and all the planets including the earth revolve around the sun, it was at once seen that such a mo-

tion of the earth must produce an annual parallax of the stars. Tycho Brahe rejected the Copernican system because he could not find from his observations any such parallax. However, the system was generally accepted as the true one and the determination of stellar parallax or the distance of the stars became a live subject. Picard in the latter half of the seventeenth century, using a telescope and a micrometer in connection with his divided circle, showed an annual variation in the declination of the pole star amounting to 40″. In 1674 Hooke announced a parallax of 15″ for γ Draconis. About this same time Flamsteed announced a parallax of 20″ for α Ursæ Minoris, but J. Cassini showed that the variations in the declination did not follow the law of the parallax.

The period which we have now reached is so admirably treated by Sir Frank W. Dyson, Astronomer Royal, in his Halley lecture delivered at Oxford on May 20, 1915, that I ask your indulgence while I quote rather freely from that source.

> Thus in Halley's time, it was fairly well established that the stars were at least 20,000 or 30,000 times as distant as the sun. Halley did not succeed in finding their range, but he made an important discovery which showed that three of the stars were at sensible distances. In 1718 he contributed to the Royal Society a paper entitled "Considerations of the Change of the Latitude of Some of the Principal Bright Stars." While pursuing researches on another subject, he found that the three bright stars—Aldebaran, Sirius and Arcturus—occupied positions among the other stars differing considerably from those assigned to them in the "Almagest" of Ptolemy. He showed that the possibility of an error in the transcription of the manuscript could be safely excluded, and that the southward movement of these stars to the extent of 37′, 42′ and 33′—*i. e.*, angles larger than the apparent diameter of the sun in the sky—were established. . . .
>
> This is the first good evidence, *i. e.*, evidence which we now know to be true, that the so-called fixed stars are not fixed relatively to one another. It is the first positive proof that the distances of the stars are sensibly less than infinite.

At the time of the appearance of Halley's paper there was coming into notice a young astronomer, James Bradley, then twenty-six years old. He was admitted to membership in the Royal Society the same year that Halley's paper was presented. He was exceedingly eager to attack the problem of the distances of the stars. At length the opportunity presented itself. To quote again from Sir Frank Dyson:

> Bradley designed an instrument for measuring the angular distance from the zenith, at which a certain star, γ Draconis, crossed the meridian. This instrument is called a zenith sector. The direction of the vertical is given by a plumb-line, and he measured from day to day the angular distance of the star from the direction of the vertical. From December, 1725, to March, 1726, the star gradually moved further south; then it remained stationary for a little time; then moved northwards until, by the middle of June, it was in the same position as in December. It continued to move northwards until the beginning of September, then turned again and reached its old position in December. The movement was very regular and evidently not due to any errors in Bradley's observations. But it was most unexpected. The effect of parallax—which Bradley was looking for—would have brought the star farthest south in December, not in March. The times were all three months wrong. Bradley examined other stars, thinking first that this might be due to a movement of the earth's pole. But this would not explain the phenomena. The true explanation, it is said, although I do not know how truly, occurred to Bradley when he was sailing on the Thames, and noticed that the direction of the wind, as indicated by a vane on the mast-head, varied slightly with the course on which the boat was sailing. An account of the observations in the form of a letter from Bradley to Halley is published in the *Philosophical Transactions* for December, 1728:
>
> "When the year was completed, I began to examine and compare my observations, and having pretty well satisfied myself as to the general laws of the *phenomena*, I then endeavored to find out the cause of them. I was already convinced that the apparent motion of the stars was not owing to the nutation of the earth's axis. The next

thing that offered itself was an alteration in the direction of the plumb-line with which the instrument was constantly rectified; but this upon trial proved insufficient. Then I considered what refraction might do, but here also nothing satisfactory occurred. At length I conjectured that all the *phenomena* hitherto mentioned, proceeded from the progressive motion of light and the earth's annual motion in its orbit. For I perceived that, if light was propagated in time, the apparent place of a fixed object would not be the same when the eye is at rest, as when it is moving in any other direction than that of the line passing through the eye and the object; and that, when the eye is moving in different directions, the apparent place of the object would be different."

When Bradley's observations of γ Draconis were corrected for aberration, they showed, according to himself, that the parallax of that star could not be as much as 1".0, or that the star was more than 200,000 times as distant from the earth as the sun.

On December 6, 1781, there was read before the Royal Society a paper by Mr. Herschel, afterwards Sir William, on the "Parallax of the Fixed Stars." We read:

> The method pointed out by Galileo, and first attempted by Hook, Flamstead, Molineaux and Bradley, of taking distances of stars from the zenith that pass very near it, though it failed with regard to parallax, has been productive of the most noble discoveries of another nature. At the same time it has given us a much juster idea of the immense distance of the stars, and furnished us with an approximation to the knowledge of their parallax that is much nearer the truth than we ever had before. . . .
>
> In general, the method of zenith distances labours under the following considerable difficulties. In the first place, all these distances, though they should not exceed a few degrees, are liable to refractions; and I hope to be pardoned when I say that the real quantities of these refractions, and their differences, are very far from being perfectly known. Secondly, the change of position of the earth's axis arising from nutation, precession of the equinoxes, and other causes, is so far from being completely settled, that it would not be very easy to say what it exactly is at any given time. In the third place, the aberration of light, though best known of all, may also be liable to some small errors, since the observations from which it was deduced laboured under all the foregoing difficulties. I do not mean to say, that our theories of all these causes of error are defective; on the contrary, I grant that we are for most astronomical purposes sufficiently furnished with excellent tables to correct our observations from the above mentioned errors. But when we are upon so delicate a point as the parallax of the stars; when we are investigating angles that may, perhaps, not amount to a single second, we must endeavor to keep clear of every possibility of being involved in uncertainties; even the hundredth part of a second becomes a quantity to be taken into consideration.

Herschel then proceeds to advocate selecting pairs of stars of very unequal magnitude and whose distance apart is less than five seconds, and making very accurate micrometric measures of this distance from time to time. The first condition should give, in general, stars very unequally distant from the earth, so that the changing perspective as the earth revolves in her orbit would give a variation of the apparent distance between the stars, while the small distance, less than five seconds, would eliminate from consideration entirely any effect upon this distance of the uncertainties in refraction, precession, nutation, aberration, etc. Herschel had already commenced the cataloguing of such double stars and in January, 1782, submitted to the Royal Society a catalogue of 269. This work did not enable Herschel to determine the distance of the stars but did enable him to demonstrate that there exist pairs of stars in which the two components revolve the one around the other. In twenty years he had found fifty such pairs.

Coming forward another generation, that is, to a time a little less than a hundred years ago, we find Pond, then Astronomer Royal, writing

> The history of annual parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sen-

sible parallax. This has happened in Italy to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the continent; and accordingly it shows a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established, beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion than that this is the reason why it discovers no parallax at all.

Within fifteen years after this statement by Pond, observations had been obtained which showed a measurable parallax of three different stars. The announcements of these results, each by a different astronomer, were practically simultaneous.

W. Struve, using a filar micrometer, determined the distance of α Lyræ from a small star about 40″ distant on 60 different days over a period of nearly three years. He obtained a parallax of $0''.262 \pm 0''.025$. Bessel, using his heliometer, determined the distance of 61 Cygni from two small stars distant about 500″ and 700″, respectively. He obtained for this star a parallax of $0''.314 \pm 0''.020$. Henderson, using determinations of the position of α Centauri by meridian instruments, deduced a parallax of $1''.16 \pm 0''.11$. All three of these results were announced in the winter of 1838–39, and indicate that the three stars are distant from the earth about 750,000, 650,000 and 200,000 times the distance of the sun from the earth.

The accompanying table exhibits the observed displacement of 61 Cygni by monthly means as given by Main from Bessel's observations. The last column gives the computed displacement on the assumption of a parallax of 0″.314. The reality of the parallax is seen at a glance.

In 1888, fifty years after the first determination of what we now know to be a true stellar parallax, Young, in his General Astronomy, gives, in a list of known stellar parallaxes, 28 stars and 55 separate determinations. Within the next ten years the number of stars whose parallaxes had been determined about doubled, due principally to the work of Gill and Elkin.

PARALLAX OF 61 CYGNI

Mean Date	Observed Displacement	Computed from 0″.514
	″	″
1837 August 23	+ 0.20	+ 0.18
September 14	+ 0.10	+ 0.08
October 12	+ 0.04	— 0.05
November 22	— 0.21	— 0.22
December 21	— 0.32	— 0.27
1838 January 14	— 0.38	— 0.27
February 5	— 0.22	— 0.23
May 14	+ 0.24	+ 0.20
June 19	+ 0.36	+ 0.28
July 13	+ 0.22	+ 0.28
August 19	+ 0.15	+ 0.19
September 19	+ 0.04	+ 0.06

Probably the most extensive piece of stellar parallax work in existence is that with the Yale heliometer. The results to date were published in 1912 and contained the parallaxes of 245 stars, the observations extending over a quarter of a century, the entire work having been done by three men, Elkin, Chase and Smith. In selecting a list of stars for parallax work an effort is made to obtain stars which give promise of being nearer than the mass of stars. At first the brighter stars were selected, and then those with large proper motions. The Yale list of 245 stars contains all stars in the northern heavens whose annual proper motion is known to be as much as 0″.5. Of these 245 stars, 54 are given a negative parallax. A negative parallax does not mean, as some one has expressed it, that the star is "somewhere on the other side of nowhere," but such a result may be attributed to the errors of observation or to the fact that the comparison stars are nearer than the one under investigation. It is safe to say, however, that

somewhat more than half of the 245 stars have a measurable parallax.

Another series of stellar parallax observations, comparable in extent with the one just mentioned, is that of Flint at the Washburn Observatory. This series includes 203 stars and extended from 1893 to 1905. These observations were made with a meridian circle, but not after the method of a century ago. The observations were strictly differential, the general plan being to select two faint comparison stars, one immediately preceding and the other immediately following the parallax star, and to determine the difference in right ascension, the observation of the three stars occupying about 5 minutes. Here as in the case of the Yale heliometer work a large proportion of the resulting parallaxes are negative; somewhat more than half, however, were found to have a measurable parallax. The average probable error of a parallax was the same in each of these two pieces of work, about 0″.03. The progress of the work during the last two or three generations is given in the following table, which contains also a brief statement of the discoveries made during the preceding century, due chiefly to efforts to measure stellar parallaxes.

APPROXIMATE NUMBER OF KNOWN STELLAR PARALLAXES

Date	Astronomer	Number of Stars with Known Parallaxes	Discoveries
1718.	Halley	No parallax	Proper motion.
1728.	Bradley	No parallax	Aberration.
1750.	Bradley	No parallax	Nutation.
1790.	Herschel	No parallax	True binary systems.
1838.		3	
1888.		28	
1898.		50 to 60	
1916.		200 to 300	

A generation ago photography entered the field of stellar parallax work, and has outdistanced all the previously employed methods for efficiency. In 1911, two publications appeared giving the results of photographic stellar parallax work, one by Russell, giving the parallaxes of forty stars from photographs taken by Hinks and himself at Cambridge, England, the other by Schlesinger, giving the parallaxes of twenty-five stars from photographs taken mostly by himself at the Yerkes Observatory, Williams Bay, Wisconsin. In speaking of these two series of observations, Sir David Gill said,

> On the whole, the Cambridge results, when a sufficient number of plates have been taken, and when the comparison stars are symmetrically arranged, give results of an accuracy which, but for the wonderful precision of the Yerkes observations, would have been regarded as of the highest class.

Schlesinger has shown that with a telescope of the size and character of the Yerkes instrument

> the number of stellar parallaxes that can be determined per annum, with an average probable error of 0.″013, will in the long run be about equal to the number of clear nights available for the work.

In other words, the Yerkes 40-inch equatorial used photographically determines stellar parallaxes with one tenth the labor required with a heliometer and with twice the accuracy.

In July, 1913, stellar parallax work was undertaken with the 60-inch reflector of the Mount Wilson Solar Observatory, and at the meeting of the American Astronomical Society at San Francisco in August, 1915, a report on that work was made. The parallaxes of thirteen stars had been determined, with a maximum probable error of 0″.010 and an average probable error of less than 0″.006, giving twice the accuracy of the Schlesinger results with the Yerkes 40-inch and from three to five times that obtained fifteen years ago. What may we not expect when the 100-inch reflector gets to work on Mt. Wilson.

At the meeting of the American Astronomical Society to which reference has just been made, two other observatories reported upon their stellar parallax work. Lee and Joy of the Yerkes Observatory reported the parallaxes of nine stars with a maximum probable error of 0″.014 and an average probable error of 0″.010, and Mitchell, of Leander McCormick Observatory, reported the parallaxes of eleven stars with a maximum probable error of 0″.012 and an average probable error of 0″.009.

The progress made in the accuracy of parallax results is shown at a glance in the following table.

THE ACCURACY OF STELLAR PARALLAX DETERMINATIONS

Date	Instrument	Probable Error	Observers
		″	
1838.....	Dorpat refractor	0.025	Struve.
1838.....	Königsberg heliometer	0.02	Bessel.
1880–1898	Cape heliometer	0.017	Gill and assistants.
1888–1912	Yale heliometer	0.03	Elkin, Chase, and Smith.
1893–1905	Washburn meridian circle	0.03	Flint.
	Photographic Results		
1910.....	Yerkes refractor	0.013	Schlesinger.
1915..	Yerkes refractor	0.010	Lee and Joy.
1915.....	Leander McCormick refractor	0.009	Mitchell.
1915.....	Mt. Wilson 60-inch reflector	0.006	Van Maanan.

From these results it appears that any star whose parallax is as much as 0″.02, *i. e.*, whose distance from the earth is less than ten million times that from the earth to the sun, should give a positive result when subjected to the treatment now employed in parallax investigations, and as eight or ten observatories are devoting their energies to stellar parallax work at present, the combined programs containing over 1,000 different stars, we ought to have soon lists of at least a few thousand stars whose parallaxes are known where our present ones contain but a few hundred.

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U. S. NAVAL OBSERVATORY

METHODS OF TEACHING ELECTRICAL ENGINEERING[1]

IN the American engineering schools must be recognized professional schools of distinctly advanced grade corresponding to the schools of the more ancient professions of medicine, law and theology. With marked sympathy for artisanship in its most useful forms, their practises and ideals are fully distinct from schools of skilled artisanship such as are in certain countries known as engineering schools; and the preparatory studies required to make students eligible to enter their courses of instruction definitely contain much work in mathematics and the sciences, in addition to an optional range of studies in the modern languages, economics and civics, history and the classics. That is, the American engineering schools are professional schools of university order, as the term university is known internationally. This form of the engineering schools in America is the result of experience and development, which has brought them to educational characteristics much resembling those of the Ecole des Ponts et Chaussees and the Ecole Polytechnique of Paris.

Originating with the third decade of the nineteenth century, the earlier American engineering schools first treated of what we now term "civil engineering," and "mechanical engineering" and "mining engineering" were later joined to the fixed curricula. It was not until 1882 that a formal course of "electrical engineering" was established, and curiously enough, this was done independently and almost

[1] Pan-American Scientific Congress, Washington, D. C., January 4, 1916.

simultaneously in two of our most noted engineering schools, Massachusetts Institute of Technology and the engineering school of Cornell University. In each of these, the first graduates completed their courses in June, 1885. Thereafter, formal courses of instruction in electrical engineering were established in most of the educational centers supporting engineering schools, until there are now ninety-five such courses in the land, embracing over 8,000 students, and from whom over 19,000 students have graduated. These courses can not be accepted as of equal rank, but it may be reasonably claimed for all that certain methods of instruction have proved serviceable and are given more or less full acceptance, depending upon the stability and strength of the organization, and the thoroughness of preparation which may be required of entering students.

Fundamentally there are two principles lying at the root of the methods of our best engineering schools, which are:

1. It is the business of these schools to train young men into fertile and exact thinkers guided by common sense, who have a profound knowledge of natural laws and of the means for utilizing natural forces for the advantage of man and the advancement of civilization. In other words, it is the business of engineering schools to produce, not finished engineers, but young men with a great capacity for becoming engineers, the goal being attained by the graduates only after years of development in the school of life.

2. The problem facing the engineering schools is more particularly a problem of pedagogy rather than a problem of the engineering profession. The problem is *how to properly train the students' powers to the stated purposes.* It must be grappled with all the directness and force of the engineers' best efforts, but it can not be solved as solely relating to the engineering profession.

Turning now toward electrical engineering, it is to be observed that electrical engineering demands industrial engineers—men with an industrial training of the highest type, competent to conceive, organize and direct extended industrial enterprises of broadly varied character. These men must be keen, straightforward thinkers, who see things as they are and who are not to be misled by fancies; they must have an extended, and even profound, knowledge of natural laws (more particularly of those relating to energy and its transformations), and an extended knowledge of the useful applications of these laws; and they must be acquainted with business methods, the affairs of the business world, and with the ways of our fellow-men.

Some of our colleagues may ask "What is electrical engineering, that it demands these things of its followers?" I will answer. Electrical engineering is that branch of the profession which deals with the generation of power, primarily from fuel or water, its conversion into electrical power which may be transmitted and distributed at will for the service of the industrialist and the householder, and, for its fullest service, electrical engineering must embrace the principles and fundamental practises underlying all the great industries and activities which it serves, and it must not shirk the controlling problems of illumination. Electrical engineering is now master of the methods of national and international rapid intercommunication, of local transportation, of ready transmission of water or steam power to a distance, of a safe and convenient method of artificial illumination, and its service in the industries is constantly enlarging, but is already probably incalculable. This is a vast field of science in the industries, which brings under

requisition the problems of mechanics, the characteristics and uses of materials and their correct application to the building of actual structures, the laws of kinematics and the processes of designing and using machinery, the special principles of hydraulics and thermodynamics and the manner in which they enter into the design, construction and operation of machines, and the manner in which they affect the usefulness of machines and the efficiencies of various industries; and it brings into association with all these the specific principles of electricity and magnetism and the ways in which these principles may be used in practise.

It is only with such definitions of the field of electrical engineering and the scope of engineering education in mind that one can truly approach a discussion of "methods" of teaching electrical engineering. Lacking such definitions, the whole connotative picture is vague, indefinite, and lacking in guide posts. Given such definitions, the problem obtains definiteness and reasonable precision. The word method then may be applied. These definitions or ideals are therefore fundamental to this address. With them as guides the word "method" has a meaning and leads directly to the proposition that electrical engineering instruction must be bilateral in character, dealing first with processes of direct logic applied in mathematical forms to the solution of problems, and second with processes of reasoning by balance of evidence such as are characteristic of the discussion of economic principles or historical sequences. These two processes of reasoning hold nearly equal importance in electrical engineering, in which respect this branch of engineering differs widely from, for instance, mechanical engineering, in which a great part of the mental processes of its practitioners must be by balance of evidence because the problems are commonly of a complexity which has not yet yielded to methods of rational analysis, thus leaving empirical methods the only resort. Thus, the design of a cast-iron bed for a great engine lathe deals with a material of unhomogeneous character which is put under tension, compression and shear, in a physical shape for which the stresses do not yield directly to mathematical analysis on account of the complexity of the form which is imposed by the requirements of convenience in operating the complete machine. In contrast to this, most of the engineering problems which relate purely to electricity and magnetism partake of the character of problems of hydrodynamics and yield directly to rational processes of analysis, *i. e.*, to assault by direct logic. In electrical engineering teaching, it is largely the economic aspects of the problems, or the problems coming in from the collateral branches of engineering on account of the intimacy with which the electrical engineer must deal with the numerous branches of mechanical industry, which call for empirical methods and reasoning by balance of evidence. These are important, and therefore the methods of teaching in electrical engineering must be bilateral, as already said, first to give the student power in direct reasoning and in designing by so-called "rational" processes, and second to give him power in reasoning by balance of evidence and in designing by so-called "empirical" processes. Along with this goes hand in hand instruction of the student in nature's laws and their relations to each other, and instruction in the applications of the methods of reasoning to minor but none the less truly engineering problems. The laboratory is a living force in such instruction, and in it the student must be substantially thrown on his own resources to execute the tests or investigations assigned to him, or

much of the merit of the instruction is lost. It is obvious that in carrying out the methods of instruction here laid down, mathematics, chemistry, physics and applied mechanics are central components of the curriculum; but history and economics have an important part.

Highly developed powers of observation and induction go far to develop a man's success in electrical engineering, as in most other professional branches, and also in those branches of business that are of leading moment. This is a collateral reason why chemistry, physics, mathematics and applied mechanics are such important studies for electrical engineers. They teach their sane followers to observe closely and accurately and to draw correct conclusions from the observed premises. But an industrial engineer must also have broadly humanistic sentiments and sympathies, and he must be prepared to reason by balance of evidence from imperfect premises. These things being facts of every-day observation, what humanistic studies can we rightfully exclude from the list useful as preparation for engineering professional life, and what methods of teaching can we exclude provided only that they are directed to the teaching of the principles of science and their applications, and do not resort mainly to descriptive processes? Our solicitude need only be exercised to see that sufficient of the mathematical and physical sciences, the historical and economic studies, and the languages make constituent parts of the curriculum; and that the spirit and order in which these are studied is right. The sciences, historical and economic studies, and languages are well represented in the curricula of many of our engineering schools, but there is still a failure to impress on the students' minds that the economic subjects are intimately related with the work of the profession.

Most American engineering schools have undergraduate curricula of four years' duration. To these come large numbers of young men from the high schools and fitting schools, mostly from seventeen to nineteen years of age. They are commonly well equipped with physical vigor and latent mental strength, but they have not yet reached mental maturity. They can not be plunged without loss into a position of complete self-reliance in their processes of study, but commonly profit from a guiding hand which shows the way to self-reliance. It is only after a couple of years of the vigorous life of the engineering schools that our American young men can profit fully by laboratory work where they are thrown mostly upon their own resources; but, having reached this stage, their progress in self-reliance and effectiveness for solving minor engineering problems go hand in hand under the stimulus of a liberal method exercised by the teachers. The more mature graduates of colleges of arts gain an equal independence and effectiveness in less time.

Bringing into the midst of such laboratory classes the additional stimulus of professional research carried on by postgraduate students who are candidates for higher degrees (Master of Science and Doctor of Engineering) and by paid research assistants, as is done in the electrical engineering laboratories of the Massachusetts Institute of Technology, introduces a final factor of pedagogical method that bids fair to make the experiment an ideal success. This plan is there coupled with the classification of students, without reflection on any, in groups according to their powers, so that the quickest to assimilate may go forward as rapidly as their powers permit, absorbing collateral matter by the way, while the slower to assimilate may cover all necessary ground at a pace which affords them

adequate thoroughness. The test of such methods by time, in the American engineering schools, is not yet complete. Indeed the last steps are quite young in our practise; but they stand high by *a priori* tests, and the few years' trial thus far made indicates an ideal result from the interassociation in the same laboratory of the undergraduate laboratory instruction by problems and the postgraduate laboratory research.

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THE JOSEPH A. HOLMES SAFETY ASSOCIATION

MENTION has already been made in the columns of SCIENCE of the movement to start a memorial to the late Dr. Joseph A. Holmes and an account of the preliminary meeting of representatives of different national associations was given in the same article.[1]

The first meeting of the permanent association was held in the U. S. Bureau of Mines, Washington, on March 4 last. The following organizations were represented:

American Institute of Mining Engineers, Hennen Jennings.
American Mining Congress, Dr. David T. Day.
American Federation of Labor, A. E. Holder.
Mining and Metallurgical Society, Dr. George Otis Smith.
American Society of Mechanical Engineers, General W. H. Bixby.
American Institute of Electrical Engineers, John H. Finney.
American Electro-Chemical Society, Dr. F. G. Cottrel.
American Association for the Advancement of Science, Dr. L. O. Howard.
American Chemical Society, S. S. Voorhees.
Geological Society of America, Dr. Joseph Hyde Pratt.
National Academy of Sciences, Dr. David White.
American Red Cross Society, Dr. Robert U. Patterson.
Western Federation of Miners, Joseph D. Cannon.
Mine Inspectors Institute, J. W. Paul.
Society for the Promotion of Engineering Education, Professor O. P. Hood (vice Professor Wadsworth).

Letters of regret were received from the following:

United Mine Workers of America, William Green.
National Safety Council, H. M. Wilson.
American Forestry Association, P. Risdale.
American Society of Testing Materials, A. W. Gibbs.

The permanent organization was effected under the name of the Joseph A. Holmes Safety Association and the following officers were elected:

President, the Chief of the U. S. Bureau of Mines (Mr. Manning).

First Vice-president, the Secretary of the Smithsonian Institution (Dr. Walcott).

Second Vice-president, the President of the American Federation of Labor (Mr. Gompers).

The members of the executive committee to serve with the other officers were elected as follows:

Mr. Hennen Jennings, representing the American Institute of Mining Engineers.
Dr. John A. Brashear, of Pittsburgh.

The present functions of the association were formulated as follows:

1. That annually the association shall make one or more awards with honorariums to be known as "The Holmes Award" for the encouragement of those originating, developing and installing the most efficient safety devices, appliances or methods, in the mining, quarrying, metallurgical and mineral industries during the previous year, these awards to be the result of reports and investigations made by the secretary and the representatives of the association.

2. From time to time the association shall also make suitable awards for personal heroism or distinguished service or the saving of life in any branch of the mining, quarrying, metallurgical and mineral industries.

3. Once a year a meeting of the association shall be held in the city of Washington at which all awards will be publicly announced.

CONVOCATION WEEK MEETING AND THE AMERICAN CHEMICAL SOCIETY

THE council of the American Chemical Society has by a vote of 61 to 31 declined to

[1] See SCIENCE, Vol. XLIII., No. 1101, February 4, 1916, pp. 164–165.

reconsider the vote fixing the annual meeting of the society in September. The circumstances of the case are explained in the following letter from the secretary of the society, Dr. Charles L. Parsons, addressed to the members of the council on March 2:

On February 14 a letter was received from Professor W. A. Noyes moving reconsideration of the recent vote selecting the date of September 25, 1916, for the time of our annual meeting rather than Convocation Week in December. Under vote of the council [*Proc.*, 1912, p. 43], it is necessary that the president certify to the urgency of this vote before it can be sent to the council. After some correspondence between Professor Noyes and President Herty, I am this morning in receipt of a letter from President Herty certifying to the urgency of the matter, and Professor Noyes's motion to reconsider is accordingly submitted to you for your opinion. Professor Noyes's motion and President Herty's letter to me regarding the matter follow:

"February 10, 1916.

"Professor C. L. Parsons,
Washington, D. C.

"*Dear Professor Parsons:* In the recent vote of the council on the date of the fall or winter meeting of the American Chemical Society I voted in favor of the September date in order that I might move a reconsideration of the question. I can not believe that the members of the council, in voting as they have, gave due consideration to the following points which favor the December date:

"1. A plan has been carefully formed to bring all of the scientific interests of the country together in one city once in five years. The December date was set in order to carry out this plan for the first time. It seems only fair that the chemists of the country should cooperate in carrying out this important scheme.

"2. The date in September which is proposed is at a time when practically all of the professors and teachers in our colleges and universities are busy with the opening of the year's work and very few of this class of our members would find it possible to attend the meeting.

"I move, therefore, that the motion fixing the date of the meeting in September be reconsidered.

"I also move that in case the motion to reconsider carries the fixing of the date of the meeting be left to the directors, or, if they prefer, postponed till the April meeting of the council.

"Very respectfully,
"W. A. Noyes"

"February 29, 1916.

"Dr. Charles L. Parsons, *Secretary*,
American Chemical Society,
Box 505, Washington, D. C.

"*My dear Dr. Parsons:* In the recent letter ballot of the council, held for the purpose of advising the president and secretary as to the wishes of the council regarding the time for holding the 1916 annual meeting, Dr. W. A. Noyes voted in favor of the September date in order to move a reconsideration. He now so moves, with the addition that in case of reconsideration the matter be left to the decision of the directors.

"Under the action of the council at the 1911 Washington meeting it becomes my duty to pass upon the urgency of this motion.

"While simultaneous action on the two motions is somewhat unparliamentary, nevertheless in view of the desirability of settling this matter as promptly as possible, I beg to certify to the urgency of Dr. Noyes's motion for reconsideration, and request that you will submit the matter to the council immediately for letter ballot.

"I regret that I can not agree with the author of the motion in his desire that the annual meeting this year should be held in December, rather than in September as has been decided by the votes of so large a proportion of the council.

"Under normal conditions I would favor most heartily the policy of meeting quadrennially with the American Association for the Advancement of Science. At the Cincinnati meeting I spoke most earnestly in behalf of this policy, but this is an entirely different world from what it was at that time.

"As a result of the European war chemistry has received a tremendous impulse in this country; the general public has been aroused to its importance to the welfare of the country; and this year of all others it is extremely desirable that we should have at our annual meeting the largest gathering of chemists that this country has ever known, for there are many problems, the solution of which demands personal conferences by men from every section of the country. There is need for the presence of both the men from the universities and the men of the industries at such conferences, and there is need of the greatest legitimate publicity of our work and aims.

"I deeply regret that it was found absolutely impossible to hold the Second National Exposition of Chemical Industries during Convocation Week. Every effort was made to do so, but all of these efforts failed through inability to secure a suitable building during that week. The exposition must be held in September. If, therefore, we should decide to hold our annual meeting in December, I am confident that it would result in a large portion of our membership attending the exposition and failing to attend the meeting of the society. This would mean a very great loss in this particular year to the prestige and usefulness of the society. The opportunity of a lifetime is in our hands. It seems to me that we would be very unwise to divide our strength just at the time when we have so wonderful an opportunity for increasing it.

"Should the council vote against reconsideration, members of the society connected with universities would not be thereby necessarily prevented from attending the annual meeting. It seems reasonable that university authorities would gladly give leave-of-absence to members of chemistry staffs in those institutions which open on or before September 25, and certainly the departments of chemistry in all of our universities would have much to gain from a meeting held in conjunction with the Second National Exposition of Chemical Industries. "Sincerely yours,

"CHAS. H. HERTY,
"*President*"

FIRST MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE first meeting of the Pacific Division of the American Association for the Advancement of Science will be held in San Diego, California, between the dates, August 9 and 12, 1916. The plans for this meeting include four public addresses upon important scientific subjects of general interest. The first of this series of addresses will be that of the president of the division, Dr. W. W. Campbell, director of the Lick Observatory, Mount Hamilton, on Wednesday evening, August 9, and will be entitled "What we know about Comets." This address will be followed by a reception to visiting scientists. The three other public addresses will occur on Thursday and Friday evenings, August 10 and 11, and on the afternoon of one of the days set aside for the meeting. Addresses will be given by Dr. Barton W. Evermann, director of the Museum of California Academy of Sciences, and by Dr. F. F. Wesbrook, president of the University of British Columbia.

Thirteen scientific societies of the Pacific coast region are now affiliated with the Pacific Division and it is expected that many of these societies, together with other scientific societies of the same region will participate in the San Diego meeting. Sessions of these societies will be held on Thursday and Friday, August 10 and 11, and at least one day of the period of the meeting, Saturday, August 12, will be reserved for excursions, which will be both of general and special scientific interest.

The Channel Islands and the region of southern California present a number of extremely interesting geological features. This region is also unique botanically and zoologically. Materials of southwestern ethnology and archeology are to be found among the Indian reservations and remains of Spanish settlements in southern California. The excursions which are to be arranged at the time of the San Diego meeting, will make accessible as many as possible of these interesting features. Among other excursions which may be taken en route to or from the San Diego meeting are visits to the astronomical observatories at the Lick Observatory on Mount Hamilton, near San Jose, and the Mount Wilson Solar Observatory, near Pasadena.

Special significance centers upon this meeting of the Pacific Division of the American Association at San Diego, since this is the first of a series of meetings which it is planned to hold annually under these auspices in the educational centers of the Pacific coast. Additional interest is given to this occasion by the Panama-California Exposition at San Diego which illustrates in its exhibits the resources of the southwest and includes a series of unusually fine collections concerning the history of man.

Preceding the San Diego meeting of the Pacific Division the first assembly in science

will be held at the Scripps Institution for Biological Research at La Jolla, near San Diego, from June 26 to August 5. The Marine Biological Station of the University of Southern California at Venice and the Laguna Beach Marine Laboratory of Pomona College will also be open throughout the summer. At Pacific Grove on Monterey Bay the Marine Laboratory of Stanford University will be open during the greater part of the summer, and will offer a summer session which will begin May 22, continuing for six weeks.

The general plans for the San Diego meeting are in the hands of the officers and executive committee of the division, which are as follows:

President, W. W. Campbell, Lick Observatory, Mount Hamilton, California.

Vice-president, D. T. MacDougal, Desert Botanical Laboratory, Tucson, Arizona.

Secretary-Treasurer, Albert L. Barrows, University of California, Berkeley.

Executive Committee: D. T. MacDougal, chairman, Desert Botanical Laboratory, Tucson, Arizona; W. W. Campbell, *ex-officio*, Lick Observatory, Mount Hamilton, California; Edward C. Franklin, Stanford University, California; Theodore C. Frye, University of Washington, Seattle; C. E. Grunsky, San Francisco, California; George E. Hale, Mount Wilson Solar Observatory, Pasadena, California; Vernon L. Kellogg, Stanford University, California; A. C. Lawson, University of California, Berkeley; E. P. Lewis, University of California, Berkeley.

Plans for meetings in special branches of science are in charge of the societies representing these several branches and the arrangements at San Diego are to be made for the meeting by a local committee of which Dr. Fred Baker, of Point Loma, is the chairman. Railroad and steamer rates for attendance at this meeting will be announced later.

SCIENTIFIC NOTES AND NEWS

DR. JOHN A. BRASHEAR, president of the American Society for Mechanical Engineers, was given the doctorate of laws at the Charter Day exercises of the University of Pittsburgh on March 20. On the evening of that day, a dinner was held in honor of the late Samuel P. Langley, secretary of the Smithsonian Institution and previously director of the Allegheny Observatory. The speakers included Dr. John A. Brashear and Dr. J. W. Holland.

WE learn from *Nature* that a committee representative of British geologists and friends of Sir Archibald Geikie has presented to the Museum of Practical Geology a marble bust. On March 14, a number of Sir Archibald Geikie's friends assembled in the museum to witness the presentation. Dr. A. Strahan, director of the Geological Survey and Museum, briefly recapitulated the history of the movement. Sir William Garforth unveiled the bust and spoke of Sir Archibald's contributions to science and literature, and then, on behalf of the subscribers, presented the bust to the museum. The Right Hon. J. Herbert Lewis accepted the gift on behalf of the Board of Education; he remarked that it was a source of gratification to the board that the artist commissioned to execute the bust happened to be another of its distinguished servants, Professor E. Lanteri, who had done so much to uphold the standards of the Royal Collge of Art. The Right Hon. Lord Rayleigh then, on behalf of the subscribers, presented to Sir A. Geikie a marble replica of the bust. In acknowledging his appreciation of the gift, Sir Archibald spoke of the powerful effect the Museum of Practical Geology had had upon him in his early student days, and of the great educational value of its collections.

THE Royal Society of Edinburgh has elected fellows as follows: Dr. R. J. T. Bell, Dr. F. E. Bradley, Mr. H. Briggs, Mr. C. T. Clough, Dr. E. J. Crombie, Mr. E. H. Cunningham Craig, Dr. A. W. Gibb, the Hon. Lord Guthrie, Professor P. T. Herring, Sir Duncan A. Johnston, Mr. H. Levy, Dr. J. E. Mackenzie, Dr. W. F. P. M'Lintock, Professor R. Muir, Dr. J. Ritchie, Mr. D. Ronald, the Hon. Lord E. T. Salvesen, Mr. D. R. Steuart, Mr. J. Martin White.

PROFESSOR LUDWIG BECKER, a native of Germany, at the desire of the secretary for Scotland, has withdrawn from the chair of astronomy in the University of Glasgow.

DR. WILLIAM E. FAULKNER, of Harvard Medical School, has left for France where he will take charge of the second Harvard medical unit.

AT its meeting held March 8, 1916, the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations: Two hundred and fifty dollars to Louis V. King, of McGill University, in aid of his research on the determination of the molecular constants of gases over the range of temperatures from 25° K. to 1273° K. One hundred and seventy-five dollars in addition to a previous appropriation for the purchase of a comparator to be loaned to Raymond T. Birge, of Syracuse University.

DR. TH. HESSELBERG has become director of the Norwegian Bureau of Meteorology.

HARRY S. SWARTH, formerly of the Field Museum of Chicago, has been appointed curator of birds in the California Museum of Vertebrate Zoology, supported by gift of Miss Annie M. Alexander to the University of California, the budget for this year being $12,000.

DR. STANLEY H. OSBORN has been appointed district health officer by the Massachusetts State Department of Health.

THE board of health of Tuscaloosa, Ala., has appointed A. F. Allen as assistant health officer. Since his graduation from Harvard-Technology School for Health Officers, Mr. Allen has been connected with the health work of Waltham, Mass., and with the epidemiological work in Fitchburg, Mass.

ALFRED W. BOSWORTH, S.B., associate chemist at the New York Agricultural Experiment Station, has been appointed biological chemist for the Boston Floating Hospital.

AT a meeting of the board of government of The National Association of Cotton Manufacturers, held on March 24, Mr. Charles H. Fish was elected acting secretary to fill temporarily the vacancy caused by the death of Dr. Charles J. H. Woodbury.

PROFESSOR R. M. STRONG will conduct the courses and investigations in ornithology at the biological station of the University of Michigan, located at Douglas Lake, Michigan.

COMMISSIONER GEORGE D. PRATT, of the New York Conservation Commission, has secured the services of Mr. Francis Harper, of New York City, to make a detailed study of the fishing waters of Oneida County, New York, as a basis for scientific working plans for fish stocking and protection.

ACCORDING to a cablegram received by the Department of Terrestrial Magnetism the *Carnegie,* under the command of Mr. J. P. Ault, arrived at Port Lyttelton, New Zealand, on April 1, having successfully completed the circumnavigation of the globe between the parallels 55 degrees south and 60 degrees south. Errors in the existing magnetic charts to the extent of 12 to 16 degrees were found.

THE fifteenth Rush Society lecture was given on April 6, at the University of Pennsylvania, by Professor John M. T. Finney, of Johns Hopkins University, his subject being "What Constitutes a Surgeon." This lecture was also the annual address before the Undergraduate Medical Society of the University of Pennsylvania.

DR. R. G. AITKEN, astronomer of Lick Observatory, gave the regular monthly lecture before the Stanford University Faculty Science Association on March 22, 1916, on the subject of "Binary Stars."

MR. GEORGE K. CHERRIE lectured at the American Museum of Natural History on March 17, to the adult blind of Greater New York on "With Colonel Roosevelt on the River of Doubt." Mr. Cherrie was the naturalist detailed by the American Museum to accompany Colonel Roosevelt on the South American trip which resulted in the discovery of the River "Duvida," now named River Roosevelt.

AT the meeting of the Royal Microscopical Society on March 15, Professor J. Arthur Thomson spoke on original factors in evolution, and Sir E. Ray Lankester on the supposed exhibition of purpose and intelligence by the foraminifera.

AT a meeting of the board of government of The National Association of Cotton Manu-

facturers, held on March 24, the following resolution was unanimously adopted:

The Board of Government desires to express its profound sorrow at the death of the secretary of the association, Dr. Charles J. H. Woodbury.

This association, and the cotton industry in general, owes to Dr. Woodbury a debt which is unmeasurable. Devoting himself in early life to the problems of mill construction and fire protection, he has, during all his official connection with the association, of upwards of twenty-five years, been the leader in all movements tending to improve the processes and methods of textile mills. Under the guidance of his trained, scientific mind, the *Transactions* of the association have recorded in the fullest degree the development of the cotton industry in its technical, historical and social aspects; and they stand as a worthy monument to his memory.

Theodore Pergande, the oldest scientific assistant in point of continued service in the Bureau of Entomology of the U. S. Department of Agriculture, died on March 23, in Washington, at the age of seventy-six. He was born in Germany; came to America at the outbreak of the Civil War; served through the war in the northern army, and later became assistant to the late C. V. Riley when the latter was state entomologist of Missouri, coming with him to the Department of Agriculture at Washington in June, 1878. He was a keen observer of the structure and habits of insects, and was especially noted for his work on the Aphididæ.

Professor Harry B. Nixon, who held the chair of mathematics at Gettysburg College, died on March 30.

Léon Labbé, a leading Paris surgeon, member of the French Institute, has died at the age of eighty-four years.

Professor Béla Alexander, director of the radiologic institute at Budapest, died at the age of fifty-seven years on February 10.

Dr. Allan M. Cleghorn, formerly assistant in physiology in the Harvard Medical School, subsequently naturalist for the Algonquin Park in Ontario, and recently captain in the Royal Army Medical Corps, has died in England after a brief illness, at the age of forty-four years.

New York State civil service examinations will be held on May 6, as follows: Physiological chemist, State Department of Health. Salary, $1,800 to $2,500. Applicants should have a thorough knowledge of the principles of organic and physiological chemistry. They must have had at least three years' practical experience in physiological or biological chemistry. Chemist, Public Service Commission, First District. $1,800 to $2,100. Men only. It is essential that candidates shall have had experience in the analysis of asphalt, coal tar, pitches and mixed paints; experience in the analysis of steel, cast iron, cement, dry pigments, water, etc., will be helpful.

According to a cablegram from London to the daily papers arrangements for the fitting out of a relief ship to go in search of Lieutenant Shackleton's Antarctic expedition were being made, though the fate of Shackleton and other members of his party was in doubt. The New Zealand authorities were urged by cable again to attempt wireless communication with the ship *Aurora,* which first reported the Shackleton party in peril. The *Aurora's* wireless message was badly garbled in transmission. Lady Shackleton as well as his explorer friends profess confidence that Lieutenant Shackleton and his men will return alive. They believe Shackleton by this time either has abandoned his attempt to cross the Polar seas from the South American side and is returning to Buenos Ayres, or that he is already safely over the South Pole and will soon join Captain McIntosh and his men at Cape Crozier. Antarctic fowls will supply the party with food if their rations run short, Polar experts declare. Only brief despatches, telling of the disaster to the New Zealand party of the Shackleton expedition, have reached London. According to these despatches, the *Aurora* broke adrift from her moorings last May during a violent blizzard. Captain McIntosh with eight men was ashore at that time establishing a food depot and engaged in scientific explorations. The *Aurora* drifted northward

in the pack ice for ten months, covering a distance of 1,200 miles. Her rudder was snapped off, but after drifting free of the ice field the crew constructed a temporary steering gear. Unless the damage to the *Aurora* was too serious, it is thought possible she may be in condition to return to the relief of the McIntosh party. If a relief ship is fitted out at once it may reach Cape Crozier and escape before winter at the South Pole, coming in June and July, closes the ice barrier again. It is most probable, however, that no relief ship will reach the cape until next December unless the *Aurora* is in shape to return.

THE meetings of the Biochemical Division will be held in connection with the spring meeting of the American Chemical Society at Urbana on Wednesday morning, April 19, and Thursday morning and afternoon, April 20. The sessions on Thursday will be devoted to the presentation and discussion of papers concerning biochemical phases of home economics. This notice is given to correct the erroneous dates published in the earlier announcement.

THE third annual joint meeting of the American Geographical Society and the Association of American Geographers will be held in New York on April 14 and 15. The papers will be delivered at the Hispanic Museum, Broadway and 156th Street, New York City, in the same quadrangle with the American Geographical Society building. The following program has been arranged, to which all interested are invited:

Friday Morning Session (from 10:30 to 12:30)

Leon Dominian, "The Geographic Foundation of Turkey's World Relations."

Mary Verhoeff, "The Kentucky River in Relation to the Kentucky Mountains." Illustrated.

Friday Afternoon Session (from 2:00 to 5:00)

Henry B. Bigelow, "Oceanographic Explorations of the East Coast of the United States." Illustrated.

H. C. Taylor, "Economic Factors Influencing the Geographical Distribution of Crops and Livestock in the United States." Illustrated.

A. Hamilton Rice, "Explorations in the Northwest Amazon Valley." Illustrated.

Saturday Morning Session (from 10:30 to 1:00)

Albert P. Brigham, "Physiographic Provinces of New York."

Harrison W. Smith, "Personal Experiences in the Society Islands and Borneo." Illustrated.

Ernest P. Goodrich, "Some Geographic Problems Incident to the Growth of a Great City—New York." Illustrated.

AT the meeting of the New York Section of the American Chemical Society, on April 7, the subject of "University and Industry" will be discussed from the point of view of the industries by William H. Nichols. Discussion will follow by Marston T. Bogert, Columbia University; Eleon H. Hooker, Hooker Electrochemical Company; Phoebus A. Levene, The Rockefeller Institute for Medical Research, and Benjamin L. Murray, Merck & Company.

THE meeting of the Astronomical Society of the Pacific was held on March 25, at the Students Observatory, Berkeley, when the following program was presented: "Comet A 1916" (Neujmin), by Miss Jessica M. Young. "The Riefler Clock," by Professor R. T. Crawford. "On the Universality of the Law of Gravitation," by Professor A. O. Leuschner.

THE Washington Academy of Sciences announces a series of illustrated lectures on nutrition, open to the public, to be given on Friday afternoons during April, 1916, at 4:45 o'clock, in the auditorium of the New National Museum. The lectures and the subjects of their addresses are as follows:

April 7. Dr. Eugene F. DuBois, medical director Russell Sage Institute of Pathology, New York: "The Basal Food Requirement of Man."

April 14. Dr. Graham Lusk, professor of physiology, Cornell University Medical College: "Nutrition and Food Economics."

April 21. Dr. E. B. Forbes, chief, department of nutrition, Ohio Agricultural Experiment Station: "Investigations on the Mineral Metabolism of Animals."

April 28. Dr. Carl Voegtlin, U. S. Public Health Service, Washington: "The Relation of the Vitamines to Nutrition in Health and Disease."

A COURSE of six lectures on military administration, medicine and surgery is being given at the College of Physicians and Surgeons, Columbia University, on Tuesdays, at 5 P.M., beginning March 28. The lectures, which are

open to the general medical public as well as to students at the college, are as follows: March 28, Organization, Equipment and Training of Armies, by Lieutenant Colonel William S. Terriberry, Medical Corps, N. G. N. Y.; April 4, Organization of the Medical Department, and Its Service in Campaign, by Major Joseph H. Ford, Medical Corps, U. S. A.; April 11, Wounds in War, their Complications and Treatment, by Major Joseph H. Ford, Medical Corps, U. S. A.; April 18, The Personal Hygiene of the Soldier, by Major Sanford H. Wadhams, Medical Corps, U. S. A.; April 25, Camp Sanitation, by Captain Philip W. Huntington, Medical Corps, U. S. A.; May 2, Preventable Diseases in War, by Captain Philip W. Huntington, Medical Corps, U. S. A.

All medical classes at the university were omitted on Thursday, April 6. The day, which is known as "U. M. A. Day," and which belongs to the Undergraduate Medical Association, was devoted to the presentation of papers and exhibits of original research work by the undergraduates and to addresses by members of the medical profession. "U. M. A. Day" was founded in the fall of 1907 by Dr. John G. Clark for the purpose of encouraging among undergraduates original research along scientific lines.

At a hearing on the Wheeler bill before the New Lork legislature, Dr. Max G. Schlapp stated according to the *Journal* of the American Medical Association, that a donor who did not wish his name divulged had offered $500,000 toward a psychopathic institution provided the Wheeler bill was passed by the legislature. This bill would create a state clearing house for the mentally deficient and would create a commission of seven with an executive manager to supervise the work of examining and diagnosing the cases of the mentally deficient and to investigate the causes of mental deficiency. No one opposed the bill.

The Department of Experimental Breeding at the University of Wisconsin has recently occupied its new barn, constructed for the accommodation of the experimental herd, and fitted out with the most modern barn equipment. An attempt is being made by means of crossbreeding to obtain data on the inheritance of dairy and beef characteristics. The herd at present consists of nearly a dozen crossbred cattle of Jersey-Aberdeen Angus parentage, and one calf of the second generation.

On the petition of Dr. J. Allen McLaughlin, state health commissioner, a bill has been introduced before the Massachusetts General Court which aims to prevent the sale or delivery of milk in any city or town without a permit from the local board of health after inspection of the facilities for producing and handling this food. It provides that the permit may contain reasonable conditions for the protection of the public health and may be revoked for failure to comply therewith. The bill has been referred by the Senate to the committee on agriculture and public health.

UNIVERSITY AND EDUCATIONAL NEWS

Harvard University has received a bequest of $51,500 from the estate of J. Arthur Beebe, and one of $50,000, came from the estate of Mrs. William F. Matchett, the income of both to be used for general purposes.

Dr. George E. Vincent, president of the University of Minnesota, delivered the Annual Charter Day address in the open-air Greek Theater of the University of California on March 23. That afternoon the cornerstone was laid of the $730,000 white granite classroom building to be known, in honor of President Wheeler, as Benjamin Ide Wheeler Hall.

Mr. F. W. Bradley, of San Francisco, has given $5,000 to the University of California for the purchase of additions to the geological and mining-arts collections of the university. A large number of exhibitors at the Panama-Pacific International Exposition have also contributed to the university's collections in these fields, among these donors being Japan, Norway, Sweden, Bolivia, United States Bureau of Mines, United States Geological Survey, the Transvaal Chamber of Mines,

Australia, Missouri, New York, California, Idaho, Anaconda Copper Company, the Utah Coal Operators' Association, the Tourmaline King Mine, the Union Oil Company, the Mascot Copper Company, the After-thought Mining Company, the Noble Electric Steel Company, the Bunker Hill and Sullivan Company, the Hockensmith Wheel and Mine Car Company, the Concordia Safety Lamp Company, the Chicago Pneumatic Tool Company and Mrs. Phoebe A. Hearst.

UPON the occasion of moving into its new quarters, the department of chemistry of the University of Illinois has issued a bulletin containing complete information of the courses given. The bulletin contains also a history of the department and pictures of the different buildings it has occupied during its growth. It contains also a list of the students registered in the chemistry courses and all alumni of the department. This bulletin will be of service on the occasion of the meeting of the American Chemical Society during the week of April 17 to 21.

A STATUTE which makes a certain amount of research a necessary qualification for the honor school of chemistry at Oxford, has been approved in congregation. The professor of chemistry, Mr. W. H. Perkin, said the main object of the scheme was to secure that every undergraduate who desired a class in chemistry must have had a year's training in the methods of research. As a result they would be able to engage in independent research and would be of more value to the country whether they ultimately adopted a teaching or an industrial career.

THE faculty of the College of Physicians and Surgeons, of Columbia University, have unanimously voted in favor of the establishment of a dental department, to be connected with the medical school. A committee of prominent dentists of the city have presented plans to the medical faculty which have been approved. The course is to be four years.

AT Yale University, Dr. Rhoda Erdmann has been appointed lecturer in biology, for the year 1916–17, on the Sarah Berliner Foundation.

DR. FRANK BILLINGS, of Chicago, has been appointed visiting lecturer on medicine at Harvard University.

AT the University of Cambridge, Mr. S. W. Cole, of Trinity College, has been appointed university lecturer in medical chemistry, and Mr. C. S. Gibson, of Sidney Sussex College, assistant to the professor of chemistry.

DISCUSSION AND CORRESPONDENCE

SEMINARY COURSES IN THE HISTORY OF SCIENCE

THE question of giving more attention to the history of science in the training of scientific men, which has already been raised in recent issues of SCIENCE, is one which should not be allowed to pass without some tangible result in the form of new courses within that little exploited field. As one who at biennial periods has conducted a seminary in the history of geology, I may perhaps be permitted to draw attention to some of the special benefits, to both teacher and pupils, which are likely to accrue from such courses.

Most important, perhaps, of the results obtained are the following: (1) A wider knowledge of the entire field of the science together with the intimate interrelations of its several parts; (2) a comprehension of what may be termed the psychology of hypothesis-making and its dependence upon the local environment of the maker, upon pure analogy, upon the scientific vogue of the period, or upon the dominating influence of leading minds; (3) a greater caution in setting up new theories upon small evidence through learning of the number and the variety of earlier theories and the relatively small number of them which have survived the test of time; (4) the valuable and often wholly unexpected side-lights which are thrown upon problems within a special field by discoveries made in other fields which were perhaps thought to be but little related.

Of these benefits I am inclined to think that much the most valuable is (2)—the realization that the scientists, as well of to-day as of yesterday, are not essentially different from their

brother mortals in the avocations, but are subject to much the same weaknesses of mental bias growing out of their early training, their religious or other beliefs, the effects of dramatic demonstrations, or the emotional effects produced by oratory and clever sophistry, as contrasted with sound reasoning divorced from such considerations.

In this connection I should like to cite a few illustrations. Who will venture to measure the part played by the unique rings of the planet Saturn in determining the form of the nebular hypothesis of Laplace, until lately accepted doctrine though now shown to be untenable? Is it not easy to see that the doctrine of a solid "crust" above a liquid earth interior—a part of the nebular hypothesis—was set up and readily accepted because the theorist who devised it inhabited a region where water congeals during the winter season and floats upon its liquid equivalent—the analogy was carried over to the substance whose relative densities in solid and liquid form were not known, from analogy with a well-known substance. Only recently has it been definitely learned that congealed rock is heavier than its liquefied form. Again, the "centrum," or explosion, theory of earthquakes, which till recently held the center of the stage in seismology, can be traced to the fact that its founder was a builder of cannon, and acquired such prestige during the Crimean War through his knowledge of ballistics that he received unusual opportunities to study a famous earthquake under the Aegis of the powerful Royal Society of London. A secondary factor in the ready acceptance of his theory by physicists particularly, was his application of the brilliant studies of Huyghens on wave propagation. Examples might easily be multiplied in order to illustrate the controlling influence of fortuitous circumstances or of striking, as opposed to solid, arguments in determining the character of the body of accepted doctrine within a science. Each worker who has given attention to the subject, will surely have encountered similar illustrations within his own field, and I feel sure that if courses in the history of science were to be more generally undertaken, they would hardly be abandoned through any lack of interest.

Wm. H. Hobbs
University of Michigan,
March 7, 1916

DEMOCRATIC ORGANIZATION IN A COLLEGE DEPARTMENT

To the Editor of Science: The work of the Entomological Division of the Minnesota Agricultural College and Station has increased to such an extent in the past four years, that, on November 1, 1915, a reorganization of the division took effect. Two other divisions were placed on the same basis. The new organization is as follows:

The name of the division is changed to that of Economic Zoology. It is divided into four sections: (*A*) Economic Vertebrate Zoology, Professor F. L. Washburn in charge, who, as state entomologist, also conducts nursery inspection work and has charge of work with mill and warehouse insects and with Minnesota Hymenoptera. Mr. Washburn retains his title of professor of entomology in the University of Minnesota. (*B*) Spraying and Tree Insects, Associate-Professor A. G. Ruggles in charge. (*C*) Field Crop Pests and Parasites, Assistant Professor C. W. Howard in charge. (*D*) Greenhouse and Truck Crop Insects, Assistant Professor William Moore in charge.

The administration of the division lies in the hands of a committee composed of the heads of sections. The chairman of the committee (an executive position) is appointed annually by the dean of the college, with the approval of the president of the university and of the board of regents. Professor F. L. Washburn was appointed chairman for the present year. The position of chairman carries with it that of entomologist to the experiment station and a state law provides that the station entomologist shall be state entomologist.

This organization is rather a remarkable step in the direction of greater democracy in the management of a university department and may interest entomologists and other science workers in universities.

F. L. Washburn
University of Minnesota

SCIENTIFIC BOOKS

A Text-book of Geology, in two parts. Part I., *Physical Geology.* By L. V. PIRSSON. Part II., *Historical Geology.* By CHARLES SCHUCHERT. John Wiley & Sons. 1915. Separately, Part I., $2.25; Part II., $2.75. Parts I. and II. bound in one volume, $4.00.

It is most fitting that this book, issued by two members of the Yale University Geological Department, should be "Dedicated to the memory of James Dwight Dana, Explorer, Geologist, Naturalist, Professor in Yale University"; to the man who first made this department so famous.

This book of 1,060 pages, with 522 illustrations and 40 plates, is divided into two parts. Part I., by Professor Pirsson, consists of 404 pages, and deals with physical geology. Part II., by Professor Schuchert, discusses historical geology and has 647 pages. It is an excellent plan to issue the parts separately, as well as combined. They are similar in size and binding to Bowman's "Forest Physiography" and Ries & Watson's "Engineering Geology." The binding is well done, the type is good, the illustrations are well produced and there are practically no typographic errors. The publishers and authors are to be congratulated upon this production.

Part I. is an excellent presentation of the fundamental facts and principles of physical geology. The subject is treated under two main captions, namely, Dynamical Geology and Structural Geology. In view of the statement made in the preface, that the author has attempted to produce a text-book which should have "a balance more even in the subject-matter composing it, than is to be found in available texts," the reader may question the space allotment assigned to the different chapters, as follows: Introduction, 5 pp.; General Considerations and Work of the Atmosphere, 22 pp.; Rain and Running Water, 42 pp.; Lakes and Interior Drainage, 10 pp.; The Ocean and Its Work, 27 pp.; Ice as a Geological Agency, 34 pp.; Underground Water, 17 pp.; The Geological Work of Organic Life, 23 pp. (is there such a thing as inorganic life?); Igneous Agencies, and Volcanoes and Hot Springs, 38 pp.; Movements of the Earth's Outer Shell, 23 pp. These chapters belong under Dynamical Geology. The structural side is treated in the remaining chapters: General Structure and Properties of the Earth, 11 pp.; Sedimentary Rocks, 39 pp.; Igneous Rocks, 21 pp.; Metamorphic Rocks, 18 pp.; Fractures and Faulting of Rocks, 17 pp.; Mountain Ranges, 31 pp.; and, Ore Deposits, 24 pp. Unless the reviewer is mistaken, he understands that the "balance" was obtained by averaging the space given to each subject by authors of older text-books of general geology.

In putting dynamical geology before structural geology the writer leads his readers from the known to the unknown. In many respects this is far more satisfactory for beginner's classes than the philosophical order according to which the masses operated upon by geologic forces should be described before considering the action of these forces.

An elementary text-book should excel, first and foremost, in the clearness of its exposition and in the choice of its illustrations. In both respects, "Physical Geology" is deserving of high praise. Almost without exception the language is lucid and concise, although we do read of "pouring dry dune sand from San Francisco" (p. 15). The half-tones are well chosen and excellently printed. With reference to the line diagrams perhaps a word of criticism may be said. Fig. 13 is incorrectly drawn; Figs. 74, 225, 227, 230 and 231 are misleading; and the perspective is faulty in Figs. 129 and 149. More uniformity might have been attained had the block diagrams been constructed either in perspective or in isometric projection, or, preferably, in cabinet projection. Thus, the blocks shown in Figs. 271, 272 and 273 might have been drawn in similar positions instead of being tilted at various angles.

There are a few places in the text where statements are misleading or incorrect. On p. 11 we find that, in a classification of work performed by the atmosphere, the chemical

destructive processes are designated *weathering,* as if there were no mechanical weathering, but this oversight is later corrected (p. 19) by the assertion that both mechanical and chemical processes fall under the head of weathering. Talus is described as having the coarser fragments above and the finer particles below (p. 22). As a matter of fact, true talus deposits, as distinguished from alluvial cones, are fine above and coarse below. "Bedrock" and "country rock" are defined as synonymous (p. 19). "Bedrock" should refer to solid rock in situ as distinguished from the unconsolidated superficial mantle rock. "Country rock" should be applied only to an older rock or rock complex, which has been invaded by younger veins or eruptive bodies. The distinction between base level and grade does not seem to be clearly brought out (p. 66). A *base level* is a *level* which controls the downward cutting of one or more streams. The control is such that each stream can reduce the inclination of its channel to a certain slope below which further downward cutting is impossible. This *slope* is *grade.* Only the lower end of such a graded stream can actually reach base level.

After all is said, these imperfections are of relatively minor importance, and they do not seriously detract from the usefulness of the volume *as a text-book.* If "Physical Geology" is also intended for a reference book—and such every elementary text-book should be with regard to the matter which it treats—its abbreviated table of contents and its incomplete index are to be deplored. In the table of contents should appear all the center and side headings employed in the text. Instead, merely chapter headings are given. Nothing described or referred to in the text should be omitted from the index. Yet coal, outwash plain, bedrock, country rock, etc., are not to be found. It is to be hoped that in a second edition the writer will correct these two grave defects.

Part II.—Professor Schuchert has given us a very readable, up-to-date book from the first chapter on "Matter and Organisms" to the last on "Earth History in Retrospect." It is unique in its method of treatment but with a uniqueness that appeals. The book consists of a series of lectures upon the principal events, physical and biologic, in the history of the earth. Each lecture or chapter deals with a single subject.

The ground is prepared for a clearer understanding upon the part of the reader by the first seven chapters, "Matter and Organisms"; "Evolution, the Constant Change of Living Things"; "Fossils, the Geologist's Time Markers"; "The Geological Time-table"; "The Lands and Their Life"; "Oceans, Their Deposits and Their Life"; "Seas, Their Nature and Deposits." There follow two chapters on the solar system, "Evolution of the Stars and the Solar System" and "Origin of the Solar System under the Planetesimal Hypothesis," the latter by Professor Barrell of Yale. In these chapters the planetesimal hypothesis of Chamberlin and Moulton is accepted as coordinating more known facts of the entire solar system than any other thus far propounded. The next chapter, "Primordial Geologic Time" applies this hypothesis more directly to the earth and its known rocks.

With the succeeding chapter begins the discussion of the history of the sedimentary rocks of the earth and their included organic remains, a consideration of the somewhat unstable continents and the ever encroaching oceans. The author, though in his research work advocating the uniform "ic" endings for the period names, very wisely in this undergraduate text-book uses the older endings, the endings used in the publications of the national surveys of the United States and Canada, of nearly all state surveys and by the majority of other geologists. There are three chapters devoted to the pre-Cambrian, "The Archeozoic Era" and "The Early and Late Proterozoic Sub-eras." Next is one on "The Paleozoic Era," in general, in which is briefly given the larger features of the North American continent during this era, especially a consideration of the more permanent land and water bodies. This includes a map (p. 577) giving the larger positive, or predominantly

rising areas, and the negative elements, the dominantly sinking areas, of the North American continent. The larger positive elements for the world are given in maps on pp. 462 and 463.

In the fifteen chapters devoted to the Paleozoic era, seven to the Mesozoic and four to the Cenozoic, the author reveals his familiarity with the geologic history of North America and its life, and here too he departs frequently from the older methods of presentation. At the first important occurrence of a group of organisms he discusses its zoology, evolution and in general its geologic occurrences, alluding but briefly to them later under the separate periods. For example, trilobites, brachiopods and all the mollusk classes are discussed between the chapters on the Cambrian and Ordovician. Fishes are given a chapter to themselves just before the Devonian discussion, and here are considered all subclasses, even though the dominant modern type of fish, the Teleostei, do not make their appearance until the Jurassic. There might be a difference of opinion as to the advisability of grouping the cœlenterates and echinoderms under the old name of "animals with a radial symmetry" and of discussing all classes of these together directly after the Ordovician.

After the general discussion of the Paleozoic one chapter is devoted to the Cambrian, one to "Trilobites" and one to "Shelled Animals." The Ordovician consumes one chapter, "Animals with a Radial Symmetry" and the "Silurian" each one. Then in succession are discussed "Fishes and the Ancestors of Vertebrates," "Devonian Time," "The Old Red," "Carboniferous of Older Geologists and the Mississippian Period," "Pennsylvanian-Permian Periods," "Rise of the Land Floras," a chapter on "Coal," and one on "The Earliest Land Vertebrates." While the discussion of coal is the best that has thus far appeared in a text-book on general geology, a brief consideration of the results of E. C. Jeffrey's work on the origin of coal and a view of one of his remarkable thin sections of coal would have added much to the completeness of the discussion.

The Mesozoic opens with a consideration of "The Triassic Period," which is followed by a chapter by Professor Lull on "Dinosaurs." Then follow in order "The Jurassic"; "Ammonites and Belemnites," a very brief chapter; "The Comanchian"; "Chalk"; "The Cretaceous Period and the Laramide Revolution." The four chapters of the Cenozoic are: "The Dawn of the Recent in Cenozoic Time"; "Evolution of Mammals and the Rise of Mentality" (including a discussion in greater detail of the evolution of the camels, horses and elephants); "Pleistocene" and "Man's Place in Nature," this last a 17-page discussion of man, biologic and geologic. The lectures close with a most concise and helpful fourteen-page summary chapter—"Earth History in Retrospect."

In the discussion of a period the author begins with a brief presentation of its occurrence in its earliest known areas, usually Europe. This is done by an account of the advances and retreats of the oceans and the mountain upheavals. Then follows a consideration of North America in greater detail, giving stratigraphic thicknesses and the paleogeography of the principal portions of the continent. This is followed by a synopsis of the life. The chapter is usually closed by a brief discussion of the climate and the economic products of sedimentary origin. The many figures illustrating the invertebrate life are commendably simplified for beginners by having their technical names banished to an appendix. Very seldom is the distribution of deposits throughout the world noted. We would thus not look to this book to find if Australia has Silurian deposits or China those of Mississippian age.

A pleasing innovation is the inclusion of the portraits of famous geologists. William Smith is given in the discussion of the Jurassic, the study of which in England led him to the discovery of the principles underlying historical geology. Lyell is given in the Cenozoic, Suess in the Cretaceous, Murchison in the Silurian and Sedgwick in the Ordovician. Of the North American workers Logan looks upon us from the pages of the Archeozoic, Hall

from the general Paleozoic discussion, William Dawson from the Devonian, Dana is given under the consideration of the permanency of continents and ocean basins, while Darwin, Wallace, Huxley and Lamarck are seen among the statements of evolution.

As was to be expected from one of the world's foremost paleogeographers not the least of the many excellent features of the book are the discussions of the past geography of the earth and the many original maps to illustrate it. There are usually several paleographic maps of North America for each period.

The book is so filled with interesting matter that it is difficult to pick out topics for special remark. It is, however, noteworthy that the text-book issuing from the university which saw the birth of Dana's "Manual of Geology" should advocate, though in a less rigid form than did Dana, the permanency of the oceanic and continental areas, the theory propounded by him. "Since the beginning of Paleozoic times the oceanic basins and the continental masses have been more or less permanent." This permanency is more flexible in the continental masses whose dominant movement is upward, for portions of these are at times invaded by the ocean or have parts of their masses faulted off into the oceanic basins.

The author's discussion of the early life of this globe must also be mentioned. "At the very base of the geologic record, in the Archeozoic," he says, "the rocks testify to a world with about the same physical environment as that of subsequent time." The presence of life in the marine waters at this time is shown by the carbonaceous shales and the large amount of graphite. No fossils are known. It is assumed that the Archeozoic was the "age of unicellular life," both plant and animal. By the close of this long era it is postulated that small multicellular plants and animals had also been evolved. Among the latter were morulæ, gastrulæ and planulæ, known at present as early embryonic stages in the development of existing animals. From the Proterozoic a small number of fossil species are known. These are "an abundance of marine algæ, some radiolarians and tubes and burrows made by annelids." The presence of annelids implies the existence of the more lowly organized sponges, cœlenterates and worms. So likewise the presence here of such other invertebrate phyla as the echinoderms, molluscoids, mollusks and arthropods is indicated by the highly evolved state of all these phyla at the opening of the Paleozoic. The author thus rejects Walcott's theory that the Proterozoic fossils thus far known are most probably non-marine and that in the at present unknown Proterozoic oceans developed the life which made so sudden an appearance in the lowest Paleozoic sediments. He agrees with Daly and Lane that the early marine waters had a different chemical content but objects that this alone could cause animals to so largely secrete chitinous, instead of calcareous skeletons, while the plant organisms, especially algæ, at the same time formed great thicknesses of limestone through their calcareous secretions.

As to the evolution of insects "it is thought that out of some Silurian or Devonian trilobite that habituated itself to the land-waters and became amphibious was derived the stem stock of insects."

That modern necessity, a good working index, is here well met. Only a few examples of oversight were noted. One was the failure to refer to the discussions of pre-Cambrian and late Paleozoic occurrences under the word glaciation. All references are to the Pleistocene.

An excellent generalization of the U. S. Geologic map, 14 by 17 inches, is inserted immediately before the index. It is thus easily accessible for reference without interfering with the usefulness of the index. It would be of still greater aid to the student if it had a blank base so that when unfolded the entire map would be visible though the back were closed. This would enable the map to be constantly before the student, no matter what part of the book he was reading. It is unfortunate that in the legend of this map the author uses the "ic" endings to the period names without

an explanation and substitutes for Paleogene used throughout the book for the lower Tertiary the term Eogenic.

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Modes of Research in Genetics. By RAYMOND PEARL, Biologist of the Maine Agricultural Experiment Station. The Macmillan Company. Pp. 182. Price $1.25.

In this book Professor Pearl has paused in the midst of his prolific and fruitful researches to put together in logical sequence around the central theme of methodology in genetics the substance of several of his recent papers and addresses.

There has been need enough for such a clear-cut analysis of the possibilities and limitations of the various methods now being utilized by workers in the expanding field of genetics and the author has performed this service most acceptably.

It is particularly gratifying to have a sane non-controversial evaluation of the much abused biometric method by one who is a past-master in biometry and is at the same time a biologist of notable attainment. It must be confessed that biometry of late years has rather needed a champion since non-mathematical biologists while admiring the magic of the biometrician, are often haunted with serious doubts about the value of the conclusions sometimes reached by this mode of investigation.

Although biometrics receives the most extended consideration of any method there is a comprehensive analysis of three other modes of research, namely, the Mendelian, the cytological and the embryological.

The next to the last, and the longest, chapter diverges into a somewhat technical treatment of the problem of inbreeding. Here the average lay reader is likely to ride through a tunnel with only intermittent glimpses of the light, but he is sure to emerge into broad daylight in the final chapter, which is upon "Genetics and Breeding," and feel well repaid for his journey. For any one engaged, or even interested, in genetic research Dr. Pearl's book will prove a most welcome and illuminating volume.

It is obvious that "Table III." on page 111 should read Table I. H. E. WALTER

An Introduction to the Study of Variable Stars. By CAROLINE E. FURNESS, Ph.D. Boston, Houghton Mifflin Company. 1915. Pp. 327. $1.75 net.

It is rather remarkable that no comprehensive work on variable stars had previously appeared in any language, though Hagen's extensive treatise, "Die veränderlichen Sterne," of which the first two parts have already been published, would soon have been completed had the war not delayed it. It is very timely in view of the great expansion in the past few years, not only in the observations of variable stars, but more especially in the deductions from their phenomena. Cosmic theories have drawn heavily on these phenomena, and seem likely to gain still more from further study.

Following the introductory chapter the work falls naturally into four divisions.

1. The equipment of the observer; maps, charts, catalogues: Chapters II. to V.

2. Photometry of variable stars; visual, photographic, photo-electric: Chapters VI. to VIII.

3. Reduction of the observations; light-scale, light-curves, elements and predictions: Chapters IX. to XI.

4. Deductions from these data; eclipsing and long-period variables, statistics, observing hints, tables: Chapters XII. to XV.

That the book is written from the standpoint of the teacher is well evidenced by the care taken to explain the fundamental ideas of each chapter. For example, the elements of spectrum analysis and radial velocity are given in considerable detail, a precaution very necessary to clarify the hazy ideas held by young students of spectroscopy. The principles underlying the photometric instruments are set forth in detail, especially the photo-electric appliances which have so recently entered the field of stellar photometry. A human interest is added by brief biographical sketches of some of the older great astron-

omers whose work laid the foundations for modern progress.

The amateur will thus find not only clear and complete directions for work, but the basic principles which enable him to understand the significance of his results. The professional astronomer will also find the book useful on account of its convenient collection of data for which he had been obliged previously to search through periodicals.

The specialist in astrophysics will naturally find some points capable of clearer statement, and some minor errors such as are apt to creep into first editions. For example, the Zöllner photometer is described on page 118 as used with the historic petroleum lamp, rather than with the modern incandescent lamp. The lack of wave-lengths on the margins of the engravings of spectra is puzzling to one not thoroughly familiar with them, especially as Plate XI. is printed with the violet end to the right, instead of the usual direction. Chapter XII., entitled "Eclipsing Binaries," includes also the "Cepheid Type," though it is not claimed that their changes can be explained by eclipses. On page 229 is the statement that "It was only with the selenium cell that it was possible to determine a change so small as 0.06 magnitude," though as a fact, the extra-focal photographs are capable of determining such changes. The use of *mg.* as an abbreviation for magnitude, is unfortunate, as it usually stands for milligram. Compare the statement in the *Scientific American* that the planet Saturn is 16 inches in diameter, due to the use of the double stroke as a sign of both inches and seconds of arc. This is not the place to give a list of typographical errors, but the statement at the top of page 102, that if star *A* is twice as bright as star *B*, the difference in magnitude is 0.44, might mislead. In the examples of the use of Pogson's rule, in Chapter V., the omission of the problem of finding the combined magnitude of two or more stars, is worth mentioning. In the historical part, the failure to give Mrs. Fleming credit for her part in the creation of the Harvard classification of stellar spectra; also the failure to credit the astronomer royal, Christie, for the "square-root" formula for the reduction of the diameters of stellar images on photographs, to magnitudes, are minor points which might be corrected.

In spite of these minor criticisms the book is a worthy contribution to the series celebrating the semi-centennial of Vassar College.

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THE VITAL EQUILIBRIUM

Following the suggestion of Nernst[1] that varying degrees of permeability of the plasma membrane might be due to a selective solubility of certain of its components, Overton established his lipoid theory. The most serious objection to Overton's theory is that, whereas it accounts most satisfactorily for the permeability of the cell for substances which normally play no part in the cell metabolism, it entirely fails to explain the penetration of sugars, salts and amino-acids, which must constitute an essential part of the cell income. Loeb[2] long ago emphasized the importance of the state of aggregation of the surface colloids as one factor influencing the conditions of permeability. This suggestion was made in connection with his experiments upon the effects of pure solutions of NaCl and combinations of NaCl and polyvalent ions on the eggs of *Fundulus*. Subsequent experiments by Loeb, Höber, Lillie and a host of others, have established beyond a doubt the existence of a physical-chemical relation between the state of aggregation of the cell colloids and the permeability of the cell. A precise and universal statement of the exact nature of this relation has never been made. In the following paper we shall attempt an analysis of the conditions determining the viscosity of cell surfaces and their importance; (1) in producing changes in permeability and (2) in "antagonisms." It appears that the metabolic

[1] Nernst, W., '90, *Zeitschr. f. physikal. Chem.*, 6, 37.

[2] Loeb, J., '01, *Pflügers Arch.*, 88, 68; '02, *Amer. Jour. of Physiol.*, 6, 411.

activities of cells, in so far as they involve an interchange of material through the surface layer, depends upon the shifting of a *surface-solution equilibrium*. Since an interchange of material eventually becomes essential for the continuation of any living system, we have called this solution equilibrium the "Vital Equilibrium."

If we examine a series of two-phase systems beginning with a coarse suspension and extending through fine suspensions, colloidal suspensions, colloidal solutions, hydrophilous colloidal the "molecular disperse" systems of Ostwald and ionically disperse systems such as dilute solutions of electrolytes like NaCl, we observe two striking changes: first, an increased subdivision of the disperse phase and, second, an increased intimacy of relation between disperse phase and solvent, a necessary result of the enormously developed surface in the former.[3] We find, furthermore, that in any of these systems there always exists an equilibrium between disperse phase and solvent. The opposing forces are in the direction of an increased aggregation and dispersion, respectively; we may therefore speak of an aggregation equilibrium. This equilibrium is shifted by the addition of solutions of any substance, organic or inorganic, by heat, ultra-violet light, etc. For example, if we add $CaCl_2$ to the negative suspension colloid As_2S_3, a precipitation occurs, *i. e.*, there is an increased aggregation of the disperse phase. Reciprocally, small quantities of 0.1 N $CaCl_2$ will clear an opaque colloidal solution of egg-white. There is an increased dispersion and the system becomes more like a true solution. Now the limits of the above series are total insolubility and complete solubility. Any change in the direction of increased dispersion means a change in the direction of a true solution, *i. e.*, an increased solubility. No sharp limits occur between true solutions and colloidal solutions. A solution of cane sugar, for example, though a molecular disperse system, certainly represents a lesser degree of dispersion than any solution of an electrolyte. Again, when two salt solutions having a common ion are combined, there appears the familiar phenomenon of association or decreased dispersion, an equilibrium shift in the direction of greater aggregation, in this case from ionic to molecular dispersion. We may therefore legitimately dispense with the term "aggregation equilibrium" and, even though we are dealing with colloidal systems, substitute the more familiar "solution equilibrium."

The hydrophilous colloids which are of particular interest to physiologists are peculiarly susceptible to slight changes in hydrogen ion concentration. Here the changes in aggregation are reversible to a far greater degree than in the colloids lower in the scale. The limits of reversibility of the solution equilibrium may be said to include a far greater range of aggregation states than in the colloids of the lower classes.

An examination of the experimental data[4] shows that for a number of different hydrophilous colloids the following anion order of dispersion obtains:

$$SO_4 < \text{Tartrate} < \text{Citrate} < \text{Acetate} < Cl < ClO_3 < NO_3 < Br < I < SCN.$$

The most indifferent region lies between acetate and chloride; SO_4 has the greatest tendency towards aggregation, while SCN produces maximum dispersion.[5] In many cases, especially in precipitation experiments, the addition of the electrolyte may have no visible effect upon the colloid. When this occurs the changed equilibrium may be detected by a vis-

[3] Höber, R., '14, *Physikal. Chemie d. Zelle u. d. Gewebe.* 4 Aufl., Kap. 7, p. 305 ff.

[4] Hofmeister, F., '91, *Arch. exper. Pathol. u. Pharmakol.*, 28, 210; Höber, R., '07, *Hofmeisters Beitr.*, 11, 35; Porges u. Neubauer, '07, *Biochem. Zeitschr.*, 7, 152; Hardy, '05, *Jour. of Physiol.*, 33, 251.

[5] By a sufficient increase in the hydrogen ion concentration the anion order may be *completely inverted.* Thus the effect of an alkali salt upon the state of aggregation of any hydrophilous colloid depends directly upon the hydrogen ion concentration. Posternak, '01, *Ann. Inst. Pasteur*, 15, 85; Pauli, W., '03, *Hofmeisters Beitr.*, 5, 27; Höber, R., '07, *ibid.*, 11, 35.

cosity determination, one of the most accessible methods for tracing changes in the state of colloidal aggregation.

The viscosity of colloids or its reciprocal, fluidity, shows peculiar variations with different degrees of dispersion. When the dispersion is greatest, *i. e.*, when the disperse phase is in "solution," we find that the fluidity is also at a maximum. An increased aggregation means a decreased fluidity which, however, continues only to the point at which the disperse phase begins to separate out from the dispersion medium as a suspension colloid or suspension. When this point is attained, the fluidity is suddenly reversed and approaches more and more that of the pure dispersion medium. Now whether the precipitation of the disperse phase is brought about by the action of electrolytes or, for example, by elevated temperature (heat coagulation) the physical-chemical effect upon the fluidity is the same (Fig. 1, *B*).

Since all substances have an influence one way or the other upon the solution equilibrium of a colloidal system, we may, theoretically, divide them into two groups; (1) those favoring solubility of the disperse phase (increased dispersion, increased fluidity) and (2) those favoring insolubility (aggregation, precipitation, coagulation, initial increased viscosity).

Turning now to the conditions of the colloids especially at the surfaces of cells, we find, in some cases, sharply differentiated membranes. In many animal cells such membranes are not demonstrable, but for our present discussion this is of little moment, since we are concerned with a colloidal boundary which must exist at the surface of every cell. In experimental studies upon single cells as, for example, animal eggs, variations in the constitution of the environmental medium produce profound changes in the cell. Whatever changes may occur within the cell as a result of such variations, it is certain that these changes are secondary to an initial or primary effect at the cell surface. Liquefying agents are believed to produce an increase in cell permeability.[6] *Arbacia* eggs, for example, when treated with solutions of sodium or potassium thiocyanate, begin to lose their pigment after two or three minutes. This is to be regarded as an expression of an increase in the normal permeability of the cell surface.

It has been shown for a number of physiological objects[7] that the deleterious action (liquefying action) of neutral alkalin salts decreases from SCN to Cl in an order corresponding satisfactorily with the Hofmeister series. In these experiments, when the solutions of the salts are brought into contact with the cell surface, the degree of dispersion of the surface colloids must be increased. The dispersion is greatest in solutions of thiocyanates and least in chlorides. A physico-chemical expression of this increased dispersion is the increase in the fluidity of the cell surface. Now, since the speed of diffusion of ions and molecules through any fluid medium depends upon the viscosity of that medium,[8] it is clear that an increased fluidity of the cell surface involves a facilitation of diffusion of soluble substances from either side of the cell surface. In other words, by a liquefying action at the surface, the permeability of the cell is increased and diffusion in both directions across the surface is facilitated.

Since there is this very definite correlation between liquefaction (dispersion) and increased permeability, it is obvious that, in the normal condition of the cell, we must have a greater aggregation of the surface colloids than during liquefaction. Bearing in mind the fact that pure solutions of all substances affect the solution equilibrium of colloids one way or the other, we should expect, *a priori*, to find certain agents producing an increased aggregation of the surface colloids of the cell; we should expect to find true solutions of

[6] Lillie, R. S., '13, *Jour. of Morphol.*, 22, 695.

[7] Schwarz, C., *Pflügers Arch.*, 117, 161; Lillie, R. S., '10, *Amer. Jour. of Physiol.*, 26, 106; Spaeth, R. A., '13, *Jour. of Exper. Zool.*, 15, 527.

[8] In the case of water-swollen gels, the speed of diffusion of crystalloids is approximately the same as in pure water, but it diminishes rapidly when the water content falls below a certain value. Bechhold u. Ziegler, '06, *Zeitschr. f. physik. Chemie*, 56, 105.

electrolytes or non-electrolytes which, when brought into contact with the cell surface, would reduce the degree of dispersion of the surface colloids. This process is not, however, a simple reciprocal of liquefaction. A *slight* increase in the aggregation of the surface colloids would involve a rise in the viscosity of the cell surface and, if an equilibrium were established, the speed of diffusion of ions and molecules across the cell surface would thus be reduced. As we noted above, the speed of diffusion of any substance across the cell surface is one index of the degree of permeability of the cell for that substance. Hence we may say that with an increase of viscosity at the surface, the permeability of the cell would be decreased. If now the concentration of the agent that is responsible for the increased aggregation at the cell surface were still further increased, there would be an additional increase in the viscosity of the surface. But, as we have already stated, the viscosity of colloids is sharply limited by the state of aggregation of the disperse phase. When the precipitating disperse phase begins to separate out from the dispersion medium, the viscosity suddenly decreases. Similarly, when at the surface of the cell the disperse phase begins to separate from the dispersion medium, *the fluidity of the cell surface* must rise abruptly. The sharp increase in fluidity would obviously involve a sudden removal of the barrier to diffusion for ions and molecules and they would pass the cell surface more rapidly.[9]

From the above considerations it seems, therefore, that the permeability of a cell may be increased either (1) by bringing into contact with the surface a solution of some liquefying agent like a thiocyanate, *i. e.*, some agent that increases the solubility (degree of dispersion) of the surface colloids and the fluidity of the surface, or (2) by bringing into contact with the surface a solution containing an excess of some deliquefying or precipitating agent like $CaCl_2$ which, by increasing the state of aggregation of the surface colloids eventually separates disperse phases from solvent, the fluidity of the cell surface approaching that of the pure dispersion medium.

The normal influences at the cell boundary must have a considerable aggregating effect upon the surface colloids since we do not normally find the cell pigments or other constituents diffusing outwards. Osterhout,[10] furthermore, has shown conclusively that certain electrolytes increase the electrical resistance of a cylinder of *Laminaria* discs. This is to be considered an expression of decreased permeability. These electrolytes ($MgCl_2$, $CaCl_2$, HCl, $La_2(NO_3)_6$) all have, in certain concentrations, a distinct coagulative or dehydrating effect upon a variety of colloids.[11] The effect of $CaCl_2$ is of particular interest since at first it increases the resistance. After a time, however, the resistance again decreases, finally falling below the initial value. This is precisely what we should expect if the effect of the $CaCl_2$ were upon the viscosity of the surface colloids. The theoretical correlation between increased dispersion and increased permeability, as well as that between increased aggregation and initial decreased permeability, is thus actually substantiated by experiment.

Permeability studies upon living cells have brought out one very striking and at first sight anomalous, fact, viz., for many substances which are not concerned with the normal metabolic processes of the cell, the cell surface is readily permeable, whereas for sugars, salts, amino acids, etc., which must constitute a large proportion of its nutritive material, it is nearly or quite impermeable. The latter substances normally occur, however, within the cell, which forces us to assume that at some previous period the surface must have permitted their passage to the cell interior. This passage to the interior of the cell could have been accomplished only under conditions of increased permeability. Now the cell content is obviously not to be regarded as permanent and fixed and we must account for a mechanism of metabolic interchange. Such a mechanism

[9] Ostwald, Wolfg., '11, *Grundriss d. Kolloidchemie*, 2 Aufl., p. 307.

[10] Osterhout, W. J. V., '15, SCIENCE, 41, 255 for a summary of results.

[11] Mines, G., '10, *Jour. of Physiol.*, 40, 327; '11, *ibid.*, 42, 309; Höber, R., u. Spaeth, R. A., '14, *Pflügers Arch.*, 159, 433.

is to be sought in some type of physical-chemical equilibrium that permits the permeability above and below a norm to vary reversibly within definite limits. We have pointed out above that there is in every colloidal system an aggregation or solution equilibrium between disperse phase and dispersion medium. The colloids at the surface of the cell are no exception to this rule. The continued action of a liquefying agent at the cell surface produces a marked increase in permeability and eventually death by irreversible liquefaction. On the other hand, a coagulating agent, *i. e.*, an agent that increases the aggregation of the disperse phases of the surface colloids, produces *at first* a decrease in permeability, but, if the action be sufficiently prolonged, the disperse phases separate out from the dispersion medium and death follows as a result of surface coagulation. Once the disperse phases have begun to separate from the dispersion medium, the fluidity of the cell surface approaches that of the pure dispersion medium which obviously involves a tremendous increase in permeability. Thus cell death, whether by irreversible surface liquefaction or by irreversible surface coagulation, invariably involves an increase in the permeability of the cell. The term "cytolysis" has been loosely applied to cover both cases, though from a physical-chemical standpoint we are dealing with antithetical processes.

The degree of aggregation of the surface colloids, *i. e.*, the degree of intimacy of relation between disperse phases and solvent appears, upon last analysis, to be the critical condition upon which depends the continuation of the cell as a living system. The degree of aggregation of the disperse phases at the surface of the cell is directly dependent upon their solubility in the dispersion medium. This solubility is determined (1) by the concentration, nature and number of electrolytes or organic substances occurring in the liquid phase, and (2) by the temperature of the whole system. We may, therefore, say: (*A*) at the surface of every cell there is a solution equilibrium, a *vital equilibrium*, between disperse phases and solvent; (*B*) the permeability of the cell is determined by the maintenance or shifting of the vital equilibrium.

We may now summarize the foregoing conclusions as follows:

1. In the limiting colloidal system of every cell, whether in the form of a differentiated membrane or not, there exists an equilibrium between disperse phases and dispersion medium.

2. A shifting of this equilibrium in the direction of greater dispersion causes an increased permeability of the cell surface, since the fluidity of the system is increased, the viscosity of the surface is lowered, and a more rapid diffusion occurs across the surface both into and out of the cell.

3. A slight shift of this equilibrium in the direction of increased aggregation involves a solidifying action at the surface, an increased viscosity, a slower rate of diffusion across the surface and a consequent decrease in permeability.

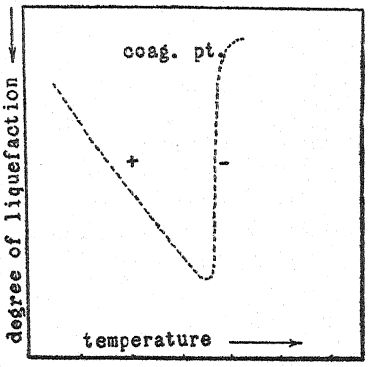
4. A considerable shift of this surface equilibrium in the direction of increased aggregation (insolubility of the surface colloids) involves a decrease in the degree of intimacy between disperse phases and solvent; the fluidity is suddenly increased and diffusion across the surface is correspondingly facilitated.

5. The critical condition of any cell surface, upon which eventually depends the continuation of the cell as a living system, is the state of aggregation of its surface colloids, *i. e.*, the relation of disperse phases to dispersion medium. We may, therefore, speak of a solution equilibrium, a *vital equilibrium* at every cell surface, reversible within definite limits, the overstepping of which produces death by surface liquefaction, on the one hand, or by surface coagulation, on the other.

We have thus far considered the cases involving the effects of single electrolytes upon the surface colloids of cells. We shall now briefly consider the physiological effects (1) of combinations of electrolytes and (2) of elevation of temperature.

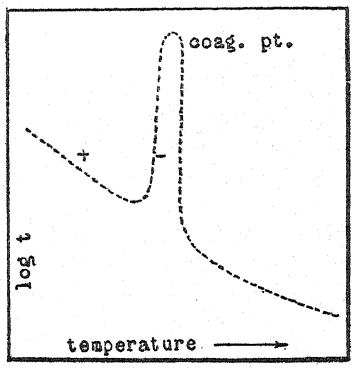
In any combination of electrolytes it is clear that if it were possible exactly to compensate the dispersion effect of one constituent or

group of constituents by the aggregation effect of another, the solution equilibrium of the surface colloids of a cell exposed to such a combination would remain unchanged. Stated in physiological terms, if we could compensate coagulative and liquefactive forces at the cell surface, the vital equilibrium would remain normal and we should obtain no injurious effect. Compensating effects of this sort are actually realized in solutions like those of Ringer and Locke, or in sea water. We have here a number of combined chemical stimuli which, when acting singly, produce distinct liquefactive or coagulative effects upon living cells, but which, in combination, are relatively harmless. According to the conception of a solution equilibrium at the cell surface, the non-injurious effects of compensated solutions of two or more constituents are to be referred to the failure of these solutions markedly to increase or decrease the solubility of the colloidal disperse phases. Such phenomena of physiological compensation have been collectively termed "antagonisms."



A.

FIG. 1, *A*. An empirical curve representing the liquefying action of atropine upon the melanophores of *Fundulus* at different temperatures. The points are relative. Thus at 22° C. there is more liquefaction than at 10° C., but less than at 36° C. At 37° C. there is again less liquefaction than at 22° C., but more than at 5° C. Up to 36° C. the temperature coefficient of liquefaction is therefore positive, while beyond 36° C. for a few degrees, it becomes negative.



B.

FIG. 1, *B*. Ostwald's curve showing the effect of elevated temperature upon the viscosity of egg-white. Here the temperature coefficient of liquefaction is positive up to about 57.5° C., while beyond this point to about 60° C. it becomes negative.

A comparison of the two curves shows that above and below a critical point in each system (36° C. and 57.5° C.) the temperature effects are antithetical.

That there is some physical-chemical principle behind all "antagonisms" is strongly suggested (1) by the appearance of the compensation phenomenon between such widely unrelated chemical substances[12] and (2) by the compensation that appears between liquefying agents and elevated temperature. This last case seems of such importance as to warrant a detailed consideration.

If a colloidal solution of egg-white be gradually heated to 35°–40° C. it becomes slightly less translucent, *i. e.*, there is an increased dispersion. A viscosity measurement[13] shows that an increase in fluidity continues uniformly up to about 57.5° C. At this point there is a sharp reversal of the reaction and the viscosity rises rapidly to about 60.0° C.,

[12] For example "antagonisms" have appeared between various alkaloids such as atropine and eserine, nicotine and curare, between alkaloids and salts as atropine and $CaCl_2$ and $MgCl_2$ and between such salts as KCl and cobalt hexamine chloride (Höber u. Spaeth, *loc. cit.*).

[13] Ostwald, Wo., '13, *Koll. Zeitschr.*, 12, 213.

the coagulation point (Fig. 1, B). Owing to this peculiar property of coagulation, which is, physically, an increase in the state of aggregation, whatever may be the nature of the chemical processes involved, we have here opposite effects produced by a slight and considerable increase in temperature, respectively; the effect of heat may be either liquefactive[14] or coagulative. We should expect, *a priori*, that by adding a powerful liquefying agent to an hydrophilous colloid, the coagulative effect of heat might be overcome wholly or in part, since this would introduce a dispersion factor into the equilibrium. This actually occurs as Pauli[15] and Pauli and Handovsky have shown. Pauli found that upon adding neutral thiocyanates, which are powerful liquefying agents, to egg-albumin, it could not be coagulated even at the boiling point of the mixture.

Four years ago I observed that the liquefying effect of atropine or atropine sulphate upon the melanophores of *Fundulus* could be distinctly reduced by sufficiently elevating the temperature of the solution. Recently[16] I have found that for temperatures up to approximately 36° C., atropine shows a normal positive temperature coefficient, *i. e.*, the liquefying effect increases with a rise in temperature. If, however, we expose contracted melanophores to identical solutions of atropine at 22° C. and at 37° C. for a period of five minutes, the cells from the warm solution show distinctly less liquefaction than those at room temperature. That the cell colloids are not coagulated by the higher temperature is shown by the activity of the cell upon being returned to NaCl or KCl solutions. Thus in this case, for a few degrees, between 36° C. and the elevated coagulation point of the cell protoplasm ($< 43°$ C.) the temperature coefficient of liquefaction for atropine becomes negative (Fig. 1, A). From the foregoing considerations we should expect an elevation in temperature to increase the solubility of the disperse phases at the surface of the melanophore.[17] We have, in addition, the liquefying effect of the atropine. Hence we have here the combined liquefying effect of atropine and elevated temperature, *i. e.*, two forces tending to drive the disperse phases of the cell surface into solution and to increase their degree of dispersion. Beyond 36° C., however, further increase in temperature tends to initiate the first steps in the process of heat coagulation involving a decrease in the state of aggregation of the surface colloids. The inhibition of the atropine effect above 36° C. is, therefore, to be interpreted as due to an elevation in the viscosity of the surface colloids which retards the diffusion of the alkaloid into the cell. Bearing in mind these antithetical physical effects of low and high temperatures, it appears that the experimental data both in the case of colloidal solutions of egg-white and in that of living cells (melanophores) comply well with the theory.[18] A liquefying agent in proper concentration may prevent heat coagulation and, reciprocally, a sufficient elevation in temperature may protect the system against liquefaction.

These physical-chemical relations may offer an explanation of the extraordinary habit of certain blue-green algæ which normally thrive at a temperature of 68° C.[19] The water in which these algæ live contains numerous salts in solution and we suspect at once that among these salts there is a powerful liquefying agent which prevents coagulation by the abnormally high temperature, as in Pauli's experiments upon egg-white. We should expect that a reduction in temperature would prove fatal to such algæ since, under these altered circum-

[14] Lillie, R. S., '15, *Biol. Bulletin*, 28, 260.

[15] Pauli, W., '99, *Pflügers Arch.*, 78, 35; Pauli u. Handovsky, '08, *Hofmeisters Beitr.*, 11, 415.

[16] Unpublished experiments.

[17] It is impossible to carry out an experiment upon the melanophores of *Fundulus* which is directly comparable to Pauli's experiments on the elevated coagulation point of egg-white. KSCN produces a marked liquefaction upon the melanophores, but only after a relatively long exposure (< 30 minutes). Atropine, on the other hand, brings about an irreversible disintegration at room temperature in concentrations of ca. 0.004 *M* in 0.1 *M* NaCl in about five minutes.

[18] See also Lepeschkin, W. W., '11, *Ber. d. deutsch. bot. Gesellsch.*, 29, 247; '13, *ibid.*, 30, 703.

[19] Setchell, W. A., '03, Science, 17, 943.

stances, the liquefying agent would be free to act. So far as we know no experiments of this sort have ever been performed, though it may be significant that Setchell failed to find any algæ growing at 43°–45° C.

In a recent paper Osterhout[20] advances the hypothesis that substances which increase permeability antagonize those which decrease permeability. He says (p. 256):

> It seems to the writer that the hypothesis offers a rational explanation of antagonism by showing that salts antagonize each other because they produce opposite effects upon the protoplasm.

The nature of these "opposite effects upon the protoplasm" is an increase or decrease of permeability. Osterhout makes no statement as to the meaning of the term "permeability" which, without further qualification, is noncommittal, nor to the *cause* of the permeability changes. With these two fundamental gaps in the theory it seems a far cry to a "rational explanation of antagonism." We have emphasized above that a study of Osterhout's data indicates a direct correlation between decreased permeability and increased surface viscosity. It seems highly probable, however, that all substances producing an initial decrease in permeability will, if allowed to act long enough or in sufficient concentration eventually cause an *increase* in permeability.[21] This conclusion, which we are forced to make from a study of the phenomena of viscosity changes in colloids, complies very well with the experimental data upon permeability changes in both plant and animal cells.

All physical and chemical agents acting upon a colloidal system influence the state of aggregation of the disperse phase, tending either to increase or to decrease the degree of dispersion. Since we have a colloidal system at the surface of every cell, all physical and chemical agents influence the state of aggregation or its equivalent, the solubility of the surface disperse phases in one of two ways, viz., (1) there may be an increase in the degree of dispersion and a corresponding increase in the solubility of the disperse phases and the fluidity of the cell surface, or (2) there may be a decrease in the degree of dispersion or a decreased solubility of the disperse phases which eventually results in a precipitation or coagulation. An "antagonism" is to be considered a physiological compensation of a force favoring dispersion (solubility) by a second force favoring aggregation (insolubility). This relation is reciprocal.

[20] Osterhout, *loc. cit.*

[21] Osterhout calls attention to this fact, but offers no explanation for it.

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SPECIAL ARTICLES

NATURAL CROSS-POLLINATION IN THE TOMATO

EVIDENCE concerning the amount of natural cross-pollination in the tomato has been secured by interplanting two commercial varieties of tomatoes, one a standard and the other a dwarf variety. The difference in habit of growth between these varieties is quite distinct in the early seedling stage. The standard is almost completely dominant over the dwarf type of growth. Any pollen from a standard plant fertilizing a dwarf plant should result in a standard plant in the first generation. To test this point a number of dwarf and standard plants were set three feet apart alternately. They were at least five hundred yards removed from any other dwarf tomatoes. These plants were allowed to set fruit normally and seed was saved from the dwarf plants as the fruit ripened. The dates on which the ripe fruit was gathered correspond approximately to the order in which the flowers were fertilized. Seed from these "open-pollinated" dwarf plants was planted in flats in the greenhouse. The number of standard plants which could be plainly distinguished after six weeks' growth was determined and tabulated.

The approximately two per cent. of crossed plants does not represent all the crossing which might have taken place. Aside from a slightly greater distance, there was an equal chance for the dwarf plants to be fertilized by pollen from other dwarf plants. This crossing would produce only dwarf plants, and hence would not show.

THE NUMBER OF STANDARD PLANTS PRODUCED FROM SEED OF OPEN-POLLINATED DWARF PLANTS

Date Ripe Fruit Gathered	Number of Plants Grown	Number of Standard Plants	Number of Dwarf Plants	Per Cent. of Standard Plants
August 10	935	28	907	2.99
" 21	61	0	61	0.00
" 27	128	1	127	0.78
September 4...	51	1	50	1.96
" 22...	995	13	982	1.31
Total	2,170	43	2,127	1.98

Whether or not cross-pollination is caused by wind or insects is not known, although no large insects, such as bees, were seen to visit the plants. Moreover, tomato pollen is dry and seems better adapted to wind transportation. This could be easily tested by screening the dwarf plants. This would not preclude the possibility of cross-pollination by thrips.

Flowers which are bagged in the bud stage and left undisturbed usually do not set fruit. Jarring the plant while the anthers are dehiscing generally suffices to cause pollination. Tomatoes in greenhouses do not set fruit well unless artificially pollinated.

It seems from this evidence that the tomato is naturally only slightly cross-fertilized. Some external agency, however, is generally needed for self-pollination as well as for cross-pollination.

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SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

AT the January meeting of the society held January 7, Professor J. A. Miller, of Swarthmore College, read a paper on "The Determination of the Distances of Stars from Us."

He sketched the attempts of Copernicus, Tycho, Braché, Bradley and Sir William Herschel to find a sensible stellar parallax. Perhaps the chief reason for desiring a stellar parallax at that time was that it would establish the truth of the Copernican system upon observational rather than theoretical evidence.

Although these men failed in their attempts to determine a parallax it was while making observations for that that Bradley discovered the aberration of light and Herschel established the fact that a physical connection exists between the components of certain double stars.

It was 300 years after Copernicus, more than a century after Bradley and a half century after Herschel before the first sensible parallax of a star was actually found when Bessell found the parallax of 61 Cygni and Henderson a parallax of α Centauri. Bessell completed his observations in 1840 and although astronomers have been working assiduously ever since, reliable parallaxes of only about 400 stars have been determined.

At present eight American observatories are working at the problem under the direction of a committee appointed by the American Astronomical Society. Most of these observatories are applying the photographic method devised by Pritchard, of Oxford. This method has since been refined and improved by various men, most notably perhaps by Schlesinger.

The Sproul Observatory of Swarthmore College is one of the eight observatories mentioned above and is spending most of the energies of its staff in that direction. They have determined in all 46 parallaxes. The program contains:

1. All visual binaries whose orbits are well determined.
2. Those visual binaries, the data concerning which leads us to believe their orbits will be determined in the not very distant future.
3. Some spectroscopic binaries.
4. Some stars of large proper motion.
5. Some stars whose hypothetical parallax is large.
6. Other objects.

Classes 1, 2, 3, receive most attention and the measurements and reductions of 13 stars of Class 1 have been completed.

Though no generalization could be made from so small a number of stars as this, yet so far as can be judged from these 13 stars, the orbits of the binaries are comparable in magnitude to the orbits of the planets. The greatest distance between two components of any double star in this list (τ Cygni) being 32 astronomical units, and the least being four astronomical units for 85 Pegasi.

The combined masses of the two components average larger than the sun. The largest mass being of Lalande 9091, which is 48 times the sun and the smallest being 20 Persei which is 0.26 that of the sun.

SCIENCE

FRIDAY, APRIL 14, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE BASIS OF PHYSIOLOGICAL INDIVIDUALITY IN ORGANISMS[1]

THE world of living things exists in the form of what we call in every-day language individuals. We must first inquire whether this word "individual," as applied to organisms or their constituent parts, has any real scientific value. Etymologically the word means something which is undivided or can not be divided, that is, it implies the existence of a unity of some sort. But divisibility is as truly a characteristic of the organic individual as indivisibility, for new individuals arise by processes of reproduction from parts of those previously existing.

How then do we recognize an organic individual? The answer is not difficult, though in certain cases it may be difficult to determine whether a particular organic entity is an individual or not. It is a certain unity and order in behavior in the broadest sense which characterizes the individual, either living or non-living. In the organic individual, whether it is a whole organism or part of it, this orderly behavior consists in a certain orderly arrangement of parts in space and a certain orderly sequence of events in time. The problem of organic or physiological individuality is then the problem of the nature of this unity and order.

Many attempts at the solution of this problem have been made. The so-called vitalistic and neo-vitalistic theories postu-

[1] Read at a joint symposium of the American Society of Zoologists and Section F of the American Association for the Advancement of Science, Columbus, Ohio, December 30, 1915.

late the existence of a non-mechanistic principle which controls and orders the physico-chemical activities. These theories have at least the merit of recognizing and meeting squarely the real problem, but while the present state of our knowledge does not permit a complete demonstration of their falsity, they are intellectually unsatisfying in many respects and particularly in view of the rapid progress of scientific method in its attack upon the problems of life.

The theories which postulate a multitude of distinct specific entities as the basis of the organism are properly speaking not theories of organic individuality at all, for they ignore the real problem. They are merely hypotheses of what we may call the metamicroscopic anatomy of the individual. The real problem of the unity and order remains not only unsolved, but its solution is placed at least beyond the present range of scientific method. Logical analysis of these theories shows clearly that their implications are fundamentally teleological and anthropomorphic. In fact so far as they are regarded as solutions of the problem they are really vitalistic theories in disguise.

In this connection let us consider for a moment the chromosome. Granting for the sake of argument the correctness of the assumptions of certain schools of scientists concerning the spatial localization of factors in particular chromosomes, it is evident that the so-called chromosome maps are nothing more than imaginary pictures of the metamicroscopic anatomy of the chromosome. If these spatially localized entities exist, they are merely anatomical characters of the organism and, as in the case of other anatomical characters, their existence, orderly arrangement and behavior remain to be accounted for. The essential problem of the unity and order of the individual is not only unsolved, but ignored, except by implication, in these hypotheses.

Concerning all the various theories of organization which in one form or another have enjoyed wide acceptance among zoologists the same objection may be made. Granting the correctness of any one of them, the postulated organization is essentially anatomical and its orderly integration remains to be accounted for. Let me make it clear that I have no quarrel with the facts along this line, so far as they are or may in the future be demonstrated to be facts. I maintain merely that they are essentially anatomical facts and as such constitute simply another step in the formulation of the real problem, not an advance toward its solution.

The rapid development within recent years of our knowledge concerning apparently specific chemical correlations between different organs or parts has led many to assert that the fundamental type of physiological correlation in the organism is of this chemical transportative character. Concerning these views I need only point out that the existence of orderly chemical correlation between parts assumes the existence and orderly arrangement of differences of some kind, in other words, of an organization of some sort. Undoubtedly chemical correlation is a factor of very great importance in determining the character of events in the organic individual, but the individual must exist as an order of some sort before orderly chemical correlation is possible. Evidently chemical correlation does not give us the solution of the problem.

The organism has often been compared to a crystal. Leaving out of consideration the fact that there is no optical or other evidence for the crystalline character of protoplasm in general, it seems to me that

these hypotheses ignore one very fundamental difference between the organism and the crystal. The unity and order of the organism are fundamentally dynamic and associated with chemical change, and when the characteristic chemical changes cease the unity and order disappear, except in so far as the anatomical record of dynamic activity may persist for a longer or shorter time. The unity and order in the crystal are static and when chemical change begins they disappear.

In this brief survey I have endeavored to bring out the fact that our biological theories of the individual, so far as they are not avowedly vitalistic or dualistic, are largely static and anatomical in fact or in implication, rather than dynamic. They are, in short, hypothetical descriptions of the machine supposed to be at work or else they tacitly assume a machine at work, but concerning the agents or processes which construct the machine and control its operation they tell us nothing. A machine which runs in a definite orderly way must be constructed according to a definite orderly plan and with the orderly employment of energy, and its operation must be controlled. In short, we must either become vitalists and admit the existence of entelechy or some other non-mechanistic principle, or else we must find some sort of dynamic unity and order as the basis of the morphological and physiological unity and order apparent to common observation. We have been trying to conceive an organic machine ready-made which shall operate in such a way as to satisfy the facts of biological observation and experiment. I believe that the essential problem is the problem of the construction and control of the organic machine. If we can gain some insight into the nature of the constructive and controlling processes we shall reach a more adequate conception of the individual than if we merely attempt to imagine a ready-made machine or individual which will satisfy the demands of observed fact. In other words, an adequate mechanistic theory of the organic individual, if such a theory is possible, must be stated in dynamic terms. It must deal primarily with processes, not structures, and with changes, not with static entities.

During the last fifteen years I have been chiefly engaged in studying and analyzing experimentally the processes of individuation in the lower animals, and this work has led me to certain conclusions concerning the nature of physiological individuality which I wish to present briefly. It has been very generally assumed by biologists that the basis of physiological individuality is inherent in protoplasm and dependent on some sort of self-determined organization. The barrenness of our theories of individuality is, I believe, the result of this view. I shall attempt to show that the physiological individual originates in the final analysis, not in a self-determined inherent organization, but in a relation between protoplasm and its environment. There are, of course, many kinds and degrees of individuality in protoplasm, both chemical and physical, such for example as atoms, molecules of the most various degrees of complexity, colloid particles, crystals, mechanical individuals such as fibrillæ resulting from strain, nuclei, cells, etc., but the integration of any or all of these into a physiological individual with a definite orderly behavior in both space and time can not conceivably be self-determined. We must either accept Driesch's entelechy or some other vitalistic principle or we must seek for the integrating factor in the relation between living protoplasm and its environment.

In what aspect of this relation can we hope to find such an integrating factor? I

believe that it exists before our very eyes in one of the most characteristic features of environmental relation, namely in spatial quantitative differences in the action of external factors on protoplasm. A brief consideration of a simple case will serve to make the point clear.

Let us begin with a mass of protoplasm, or a cell mass which is undifferentiated, *i. e.*, in which no morphological differences and no localized quantitative or qualitative differences in the metabolic reaction beyond those characteristic of protoplasm or cells in their simplest terms are present. Such a protoplasmic or cell aggregate may include individualities of various kinds, as I have already pointed out, but it is not integrated into a physiological individuality, as a whole, nor does it possess any inherent capacity for such integration.

If now such an aggregate is subjected to the differential action of environment by permitting an exciting factor, a stimulus, to act upon some point of its surface the first result is an increase in dynamic activity in the region immediately affected. It is a familiar fact of physiology that the dynamic effect of such a local excitation does not remain limited to the region directly affected by the external exciting factor. The local excitation is followed by the spreading or transmission through the protoplasm or over its limiting surfaces from the point immediately affected, of some sort of dynamic change, which itself acts as an exciting factor. For present purposes the fact of transmission, rather than the nature of the transmitted change concerns us.

Secondly, we know that in protoplasm in general such transmitted excitations decrease in energy, intensity, or in our present ignorance we may say in physiological effectiveness, with increasing distance from the point of origin, so that at a greater or less distance they become inappreciable or ineffective. This range or limit of effectiveness depends, of course, on various factors, the degree or intensity of the original excitation, the capacity of the protoplasm for transmitting excitations, etc. The case is analogous in certain respects to the spreading of a wave in water, air or any other physical medium from the point of disturbance.

Since a decrement in effectiveness occurs in transmission, the degree of excitation associated with it will be greatest at the point of origin and will decrease with increasing distance from this point. That is to say, a gradient in excitation appears in which the point of original excitation by the external factor constitutes the region of highest rate, intensity, or effectiveness. Such a dynamic gradient represents, I believe, the simplest form and the starting point of physiological integration in living protoplasm.

If the action of the external factor is of short duration this dynamic gradient usually exists for only a short time and leaves little or no appreciable persistent change in the protoplasmic substratum. If, however, the action of the external factor is sufficiently long continued or sufficiently often repeated, the protoplasmic changes sooner or later become more or less evident and more or less persistent. These changes are fundamentally changes in irritability, in the capacity of the protoplasm to react, and since these changes are in general proportional to the rate or intensity of dynamic activity in the protoplasm the dynamic gradient may produce in the protoplasm an irritability gradient. The differences in irritability at different levels are more or less persistent, and when once established tend in general to become intensified up to a certain point. In short, a dynamic or metabolic gradient arising as the result of

local excitation by an external factor may become the starting point of a persistent or permanent and primarily quantitative order in the living protoplasm, and such an order as this represents, I believe, a physiological axis or the physiological individual in its simplest form. The first order of this kind to arise in a given mass of protoplasm becomes the chief, polar, or major axis, and other similar orders established later determine minor axes, *i. e.*, the symmetry.

We now turn to the question of the nature of physiological relation or correlation in such an order as this. The fundamental relation must be one of dominance and subordination. The region of highest irritability or rate of reaction must dominate all regions of lower rate within the effective range of the excitations transmitted from it because to any stimulation of the system it reacts more rapidly or more intensely than other regions, and its greater irritability determines that it shall react to some conditions which are not effective in other regions. Consequently the excitations transmitted from this region of highest rate are more effective in determining the general metabolic rate at other levels of the gradient than the changes transmitted from any other region. The region of highest irritability or rate of reaction in such a gradient is then a physiologically dominant region, because it is the chief factor in maintaining the gradient after it is established and so in determining the general metabolic rate at each level. This dominant region of the gradient is relatively independent of other regions while they are relatively subordinate to it. In general any level of the gradient is dominated by higher levels and in the absence of these higher levels itself dominates lower levels.

The region of highest rate of reaction in the chief or major gradient becomes in development the apical region or head of the individual and a definite localization and course of development along the major axis occurs, and the localization of organs with respect to the minor gradients is also definite and characteristic. The orderly specialization and differentiation in such an individual results from the differences, primarily quantitative, which exist at different levels of the gradient.

These conclusions are based on many different lines of evidence which can be referred to only very briefly: First, a gradient in metabolic rate in which the region of highest rate becomes the apical region of the individual has been demonstrated as a characteristic feature of the major axis in animals, at least during the earlier stages of development. There is also much evidence to show that the minor axes are represented by similar gradients. The physiological individuals examined thus far include the amœba pseudopodium and various other protozoa, celenterates, flatworms, echinoderms, annelids, fishes, amphibia and birds, in all more than fifty species. Among the plants various species of axiate algæ have also been examined and a similar gradient with its region of highest rate at the apical end of the axis has been found in all. In many cases these dynamic gradients are readily distinguishable before any visible morphological differences along the axes exist.

Moreover, the very general existence of developmental gradients along the axes in both animals and plants constitutes very strong evidence for the existence of metabolic gradients, even where these have not been directly demonstrated. As regards the major axis of the animal, the so-called law of antero-posterior development is essentially a statement of the fact that morphogenic development begins or proceeds most rapidly in that region which becomes the apical or anterior end of the animal, and in

minor axes definite developmental gradients also exist. In the axiate plants essentially similar relations are found. The development of the individual proceeds from the apical end, the growing tip of the axis. In axiate organs and parts also metabolic gradients and developmental gradients correspond, so far as observation goes at present. In processes of experimental reproduction or reconstitution in pieces of the lower animals the same relations between metabolic gradients, axes and the course of development have been found to exist as in embryonic development.

Second, experimental teratogeny affords evidence of great value concerning axial metabolic gradients and even makes it possible to demonstrate their existence in certain cases where other means are technically unavailable or unsatisfactory. The method of experiment along this line depends upon the fact that the degree of susceptibility of living protoplasm to at least many, perhaps to all, agents commonly characterized as depressant or inhibitory, is very definitely related to the rate of metabolism together with the correlated protoplasmic conditions. This relation is briefly as follows: to a high intensity of action of agents and conditions, which kills without permitting the protoplasm to adapt or acclimate itself, the susceptibility varies in general directly with general metabolic rate. The higher the rate the earlier death occurs, and *vice versa*. To a low intensity of action which permits the protoplasm to adapt or acclimate itself to some extent, the susceptibility in the long run varies in general inversely with the metabolic rate, because, the higher the rate, the greater the capacity for, and rate of acclimation. We see these relations more or less clearly in the susceptibility of young and old organisms to various external conditions. To extreme conditions the young with their higher metabolic rate are more susceptible than the old. Medical practise in the administration of drugs to children and adults recognizes this difference in susceptibility, though so far as I know it has never been formulated in general terms. On the other hand, the young organism adapts or acclimates itself more readily and rapidly than the old to conditions which are not too extreme to permit acclimation. There is a large body of evidence in support of these conclusions concerning susceptibility which can not be considered here.

The point to which I wish to call attention is the relation between susceptibility and metabolic rate on the one hand and developmental control and experimental teratogeny on the other. If the major axis of the animal egg, or embryo, is primarily a metabolic gradient with the highest rate in the apical region, we should expect this gradient to appear as a susceptibility gradient to various external factors. This I have found to be the case. By subjecting, for example, the unfertilized egg or the embryo of the sea urchin in various early stages to rather extreme action of various agents and conditions it is possible to obtain a gradient in inhibition of development in which the apical region is most inhibited, the basal least. On the other hand, with agents or conditions whose action permits some degree of adaptation or acclimation, the apical region, though at first most inhibited, is in the long run least inhibited, the basal most, because the apical region possesses greater capacity for acclimation than the basal. By this means two opposite types of teratological larvæ are obtained, the one with apical region most inhibited and therefore disproportionately small and retarded in development, the other with the apical region least inhibited and therefore disproportionately large and advanced in development. Between the two ends of the axis the degree of

inhibition differs with the level in the gradient. Similar differences in degree of inhibition along the axes of symmetry are also present in such cases. In this way the whole shape, proportions, and degree of development of different parts can be modified and controlled to a high degree and in two opposite directions. Similar results have been obtained with other forms. Moreover, at least most cases of experimental teratogeny resulting from the action of chemical agents and general environmental conditions, as well as many teratological forms observed in nature can be readily interpreted on this basis. Experimental teratogeny then affords, on the one hand, a valuable check on other means for demonstrating axial gradients, and, on the other, finds a simple interpretation, at least as regards many of its features, on the basis of the general conception of metabolic gradients.

Third, it is possible in some of the lower animals to eliminate the original axes in isolated pieces by means of narcotics, and then to establish a new axis in a different direction by subjecting the pieces to a gradient in external conditions. The shorter the piece, the less marked the original polarity and the more readily new polarities arise in response to the differential action of external factors. Very short fractions of the axis may be completely apolar in their behavior. This fact indicates that physiological polarity is not, as often assumed, a property of the protoplasmic molecule, but rather a function of protoplasmic mass, as it must be if it is fundamentally a metabolic gradient.

Fourth, it has been possible to demonstrate experimentally for certain of the lower animals that a relation of dominance and subordination exists along the major axis. The apical region dominates all other levels of lower metabolic rate within the range of its influence, and in the absence of the apical region the highest level of the gradient present dominates all levels below it and within its range. The apical region itself, however, is to a high degree independent of other levels of the axis. In the reconstitution of pieces it is capable of developing, at least to a very advanced stage, and in the lower animals, apparently completely in the entire absence of other parts. The development of hydranths or apical portions of hydranths from short pieces of *Tubularia* stem, which has been described by various authors, is an example. Other levels of the body, however, never arise in reconstitution except in connection with more apical or anterior levels, though an apical end need not be present to determine their formation. In axiate plants the relations are essentially identical as regards the major axis. The dominance of the apical region, the growing tip of plants, over other levels has long been recognized by botanists. Moreover, in plants the apical region may arise in the absence of other parts, and the development of other parts takes place basipetally from it.

In the experimental reproduction of various simple animals, I have found that when the metabolic rate in the apical region is decreased, organs along the axis arise nearer to the apical end and to each other, while increase in metabolic rate of the apical region determines their localization farther away from it and from each other. If the localization of these organs is determined by a certain position in the axial gradient this relation between localization and metabolic rate in the apical region is easy to understand, for when the rate is low the gradient is shorter and the dynamic conditions for a particular organ arise nearer the apical end, while a high metabolic rate means a longer metabolic gradient and the

localization of these conditions at a greater distance.

The relation of the central nervous system to the axial metabolic gradients is a point of particular interest. The apical or cephalic part of the nervous system develops from the apical region of the major axis which is, at least primarily, the region of highest rate in the whole body and the postcephalic portions develop in or near the region of highest rate in the symmetry gradients, the median ventral region in the bilateral invertebrates, the median dorsal region in the vertebrates.

If the organic individual consists primarily of a number of qualitatively different entities between which chemical transportative correlation exists, it is difficult to understand why it should transform itself during development into an individual which is dominated by a nervous system, in which transmitted changes instead of transported substances are the means of correlation. From this point of view the nervous system seems to arise from nowhere and out of nothing as an added superior system which integrates the previously existing mosaic of entities or qualities into an individual. From the dynamic viewpoint, according to which a physiological axis is primarily a metabolic gradient, the appearance, localization, course of development and functional dominance of the central nervous system are the natural and necessary consequences of the relations of dominance and subordination which have existed in the axial gradients from the beginning. The central nervous system is in fact merely the final morphological and physiological expression of dynamic relations which constitute the first step in individuation.

Brief mention of some other cases of functional dominance in relation to metabolic gradients is perhaps of interest. Mayer has shown that in the medusa *Cassiopea* that particular one of the marginal nerve centers which has the most rapid rhythm initiates the wave of muscular contraction and for the time being sets the pace for the others. Dominance here is of course only temporary. In the vertebrate heart the sinus region is dominant and initiates the beat. Dr. Hyman has been able to demonstrate that in the tubular embryonic heart an axial metabolic gradient exists and the region of highest rate in this gradient develops into the sinus. Tashiro has recently shown that a metabolic gradient exists in the neuron and that conduction of impulses is normally down this gradient.

Fifth, the localization of, and the conditions determining, various processes of agamic reproduction of new individuals from parts of those previously existing afford valuable evidence in support of the dynamic conception of the individual. Since the transmitted changes in protoplasm undergo a decrement in effectiveness with increasing distance from the point of origin, their range of effectiveness, in other words the range of dominance, is spatially limited. This range may vary with different conditions, metabolic rate in the dominant region, intensity of transmitted excitation, conductivity of protoplasm, interference with other transmitted excitations, etc. The range of dominance in a particular axis in a specific protoplasm under given conditions represents the physiological maximum of size which the individual can attain in that dimension under those conditions and remain physiologically an individual. Any part which comes for any reason to lie outside the range of dominance is thereby physiologically isolated and no longer physiologically a part of the individual. In most plants and lower animals such physiological isolation of a part, like physical isolation, is usually followed by

more or less dedifferentiation and rejuvenescence and then by reproduction of a new individual. In agamic reproduction in general such physiological isolation is a fundamental factor. Physiological isolation may occur in consequence of continued growth in size or length of the body to such an extent that some part becomes physiologically isolated. Second, it may also occur in consequence of decrease in metabolic rate in the dominant region, thus decreasing the range of dominance, until finally the limit of dominance is less than the length of body along the axis concerned. Third, physiological isolation may also result from a decrease in conductivity in the path of transmission, thus decreasing the range of effectiveness of the transmitted excitation, or in extreme cases blocking it. And finally, physiological isolation may result from the local action of an exciting factor on a subordinate part, increasing its metabolic rate to such an extent that it becomes independent of, or insusceptible to the dynamic changes transmitted from the dominant region. The best proof of the correctness and adequacy of this conception lies in the fact that experimental determination and control of physiological isolation and reproduction are possible, either in plants or animals, in all these ways. To mention only one case, in many plants and in various simple animals we can induce agamic reproduction, not only by inducing growth in size, but by inhibiting or removing the apical dominant region.

In order that the physiologically isolated part may give rise to a new individual it must either retain to some degree in its protoplasm the axial gradient or gradients determined in it while it was still physiologically a part of the parent individual, or else new gradients must be determined in it by the differential action of external factors. We find both these possibilities realized in nature and in experiment. In short, the phenomena of agamic reproduction in both plants and animals afford very strong evidence in support of this conception of the organic individual.

Gametic reproduction differs from agamic, first, in that the gametes are more highly differentiated, physiologically older cells than those concerned in agamic reproduction and require in most cases the special conditions of fertilization to initiate the process of reproduction and rejuvenescence; second, in that the isolation of these cells from the parent body in multicellular forms is not directly connected with the range of dominance in the individual, but seems to be rather a process of elimination or extrusion of cells which, so far as the parent body is concerned, have completed their life-cycle, are approaching death and have no further rôle to play as physiological parts of the body and are got rid of like other inactive waste material.

One or two other points require brief consideration. I have endeavored to make it clear that the physiological integration of protoplasmic parts or of cells into an individual with a definite characteristic orderly behavior in space and time is not self-determined by some sort of organization inherent in the protoplasm, nor by some non-mechanistic integrating principle such as Driesch's entelechy, but in the final analysis by the relation of the protoplasm or cells concerned to the environment, primarily the external environment, though in the individuation of parts of an organism the intra-individual environment may be the effective factor. In fact, physiological individuality is fundamentally the result of interrelation between living protoplasm and its environment. The fact that morphological and physiological order in development and evolution are primarily superficial, as for example in the protozoa and in most

plant cells where only the superficial layers of the protoplasm show a definite persistent morphology receives a simple interpretation from this point of view, while from any other standpoint it is difficult to find a reason for this superficial appearance of order. The superficial origin of the nervous system in development is perhaps the most notable case in point.

It is not necessary, however, to assume that every organic individual arises directly through the differential action of environmental factors. When the metabolic gradients with their associated protoplasmic conditions are once determined in a mass of protoplasm or cells they or their protoplasmic substratum may persist for many generations through division or other reproductive processes. In other cases factors in the intra-individual environment may determine the gradient or gradients in certain parts. The polarity of the egg, for example, shows in most cases in both animals and plants a definite relation to the point of attachment of the growing egg cell to the parent body, and there is good reason to believe that the differential action of the egg's environment in the organism determines its polarity. In some cases, however, this polarity, if present, is apparently eliminated and a new polarity established by external factors acting after isolation, as for example in the egg of the alga *Fucus*, where the axis of the egg and so of the plant is apparently determined by incident light, or in its absence by other differential relations to external conditions. Evidently a physiological axis may be inherited through one or more generations after it is once established, or it may be determined *de novo* in each reproduction. Experiment demonstrates that even in many cases where it is inherited in nature we can eliminate it and determine the establishment of a new axis by the differential action of external conditions.

Considering for a moment another point, the question may be raised whether a mere gradient in rate of metabolism with its correlate of protoplasmic condition is adequate to account for the differentiation that arises along an axis in development. To those who have been accustomed to postulate a great number of qualitatively different entities as the starting point of the organic individual such a conception may seem to be almost ridiculously inadequate. The facts, however, are these. We can produce experimentally morphological differences which are clearly qualitative through the action of external factors, such, for example, as temperature, which act on metabolism primarily in a purely quantitative way. Moreover, it is clear from various lines of evidence that the character of the substances which accumulate in a particular protoplasm as components of its structural substratum is very closely associated with metabolic rate. When the rate is high only certain substances produced in the course of the metabolic reactions and which are relatively stable under these conditions can accumulate as a structural substratum, while other substances are broken down and eliminated. With a lower metabolic rate some of these other substances do not break down so readily and therefore they also may accumulate and so on. Take the simple case of the accumulation of fat in a cell. We know that a low metabolic rate favors fat accumulation and a higher rate may lead to its disappearance. But we can not doubt that after the accumulation of fat in a cell has begun, the presence of the fat alters the metabolic processes occurring in that cell: its appearance in the cell is associated with a certain metabolic rate, but once present it may alter not merely the rate, but the kind of metabolism which occurs. Various factors indicate also that differ-

ences in metabolic rate may determine the production of different substances. On the basis of these and other lines of evidence, I believe that we are fully justified in maintaining that purely quantitative dynamic differences, *i. e.*, differences in metabolic rate may and do serve as the starting point of very great qualitative differences, both in structural constitution and character of metabolic reaction. In short, both physiological and biochemical facts support the view that a metabolic gradient is adequate to account for the beginning of differentiation along a physiological axis, and the burden of proof must rest on those who maintain that it is not. Of course the character of the qualitative differences which arise from the quantitative, must depend on the specific constitution of the protoplasm concerned.

It is evident that as soon as orderly differences arise chemical transportative correlation between the different parts must play a very important rôle in determining the character and course of further developmental changes, but it is also evident that such chemical correlation can not exist until differences exist nor can it be orderly or definite in character unless the differences on which its existence depends are orderly and definite. The conception which I have presented is an attempt to show how these orderly differences arise and make possible chemical correlation.

To sum up, physiological individuality depends fundamentally and from the beginning on the transmission of dynamic excitations and not upon the transportation of substances. Transportative correlation, while of great importance, is a secondary factor, playing a rôle in determining the course and character of development, but not in determining the existence of an individuality. And, furthermore, the facts indicate that a definite orderly transmissive correlation can originate only in a region of relatively high metabolic rate determined in the final analysis by factors external to the protoplasm concerned. Transmission from such a region of high rate determines a metabolic gradient together with its protoplasmic correlates, and so constitutes a physiological axis, a physiological individuality in its simplest form.

In conclusion I wish to point out the fundamental similarity from this point of view between the physiological and the social individual. The organism has often been compared to an ordered community of human beings or a state, but in these comparisons the question as to the factor or factors which determine the orderly character of the organism has usually been ignored. In the social individual it is authority or government which integrates the human units into an orderly whole. I have attempted to show that an authority or government of a simple dynamic kind is the primary integrating factor in the physiological individual. There are, moreover, certain rather fundamental similarities which are more than far-fetched fanciful analogies between government in the organism and in the social individual.

In its simple primitive forms, such as tribe, clan, etc., the social individual is integrated by the authority of a dominant person or perhaps of a group and this authority consists fundamentally in what we call brute force, which is something not very different from high metabolic rate in the organism. The dominance of the ruling personality depends, not upon the transportation of material from him to other members of the community, but upon the transmission of personal influence, and the size of the primitive social individual depends on the extent to which he is able to make this influence felt, *i. e.*, on his per-

sonal authority, the degree of his dominance and the means available for its transmission. The border regions of this social individual are but little under his influence and may become physiologically isolated in the same way that parts of the organism become physiologically isolated, either by growth in size of the whole so that the dominant personality can not longer control the outlying portions, by a decrease in his dominance as the result of advancing age, illness or other conditions, by obstacles to transmission of his authority, or finally in consequence of local conditions which make the particular group of persons more or less independent of or less receptive to the original authority. As in the organism, any of these conditions may result in the reproduction of a new orderly individuality like the old or different from it according to the character of the isolated group and the environmental conditions. The only condition necessary for this sort of reproduction in the physiologically isolated part of the social individual is the existence or development of a new dominant personality and neither an isolated part of an organism nor a group of human beings can exist for any great length of time in a natural environment without the appearance of differences of this sort between component parts.

I have maintained that the orderly physiological individual can not arise on a basis of chemical transportative correlation and we can see very readily that the state can not arise on a basis of barter and exchange or commerce. When once different individualities are established the character of material exchange may be an important factor in determining their further course of development, but the social individual originates in authority and its transmission, not in the exchange of substance.

The evolutionary development and differentiation of the social individual also parallels the evolutionary and individual development of the animal organisms. Specialization and differentiation of different parts occur as the result of local commercial or other conditions, and the means of transmission and transportation also develop, so that the physiological limit of size increases to an indefinite degree and physiological isolation of parts is much less likely to occur. The governmental authority and the means for its transmission develop into a complex machine comparable to the nervous system of the animal.

In fact we can even find a parallel in the organism to the approach toward democracy with advancing evolution of the state. The simple organism and the earlier stages of development of the higher forms are fundamentally of the primitive monarchical type. The dominant region is wholly or to a large extent independent of other parts, but dominates them. As organic evolution and development proceed, however, we find sooner or later that the development of the dominant region, the cephalic central nervous system, begins to be influenced by subordinate parts. This influence may result either from transmission or transportation. In certain reflexes in the higher organisms there is something very similar to the delegation of authority by the people to the government. We might say that in the evolution and development of the organism as in that of the state, government becomes more and more a representative government.

These similarities, I am tempted to say these fundamental identities, between the physiological and the social individual are based on the fundamental nature of living things. This close parallelism between those two dynamic individualities seems to me to constitute in itself evidence of great importance for the conception of the physi-

ological individual which I have tried to present.

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THE BASIS OF INDIVIDUALITY IN ORGANISMS FROM THE STANDPOINT OF CYTOLOGY AND EMBRYOLOGY[1]

I

AN individual in the broadest sense is any animate or inanimate thing which is regarded as a unit. In this sense the electron, atom, molecule, crystal, biophore, determiner, chromomere, chromosome, nucleus, centrosome, cell, organ, system, person, corm, state, species, etc., are individuals. In all but the simplest units individuality involves organization, that is differentiation into parts and integration into a single whole. A fundamental property of any unit is its separateness or separableness, from other units, and yet no unit is completely independent. Biological units are separate in both structure and function from other units and yet they are related to others and these relations may be of such a sort that they constitute units of a higher order. Organic individuality of whatever order is dependent upon separateness of structure, of growth and of division. But while all vital units are separate or separable, they vary greatly in independence from the parts of a cell which are incapable of independent life to cells and to persons which are capable by themselves of maintaining life processes. The failure to distinguish between separateness and independence has been a fruitful source of misunderstandings in biological controversies.

[1] Read at a joint symposium of the American Society of Zoologists and Section F of the American Association for the Advancement of Science, Columbus, Ohio, December 30, 1915.

An organic individual then is any unit capable of manifesting the properties of life. The simplest and most fundamental properties of life are: (1) Metabolism, especially assimilation and growth, and (2) Reproduction by division. Every vital unit manifests both of these properties from the ultra-microscopical units of living matter to its more complex aggregates. To these two properties there is usually if not invariably added (3) sensitivity or the capacity of responding to stimuli, frequently in a beneficial or adaptive way. An organic individual then is capable of assimilation, growth and division and it may be irritable or sensitive. This definition can not be made more specific, for individuality is not a hard and fast thing. There are all degrees of organic individuality from the simplest and smallest units of living matter to the largest and most complex. As applied to human beings and their organization into society, the word "individuality" has come to have a metaphysical and mystical significance and not infrequently this mysticism has been extended to all forms of individuality.

1. *Individuality of Ultra-microscopic Units of Living Matter.*—Long ago Brücke (1861) maintained that protoplasm must be composed of ultra-microscopic units capable of assimilation, growth and division and these units he called "the smallest living parts." Many students of the subject since that time have postulated similar units; such as the "physiological units" of Spencer, the "gemmules" of Darwin, the "plasomes" of Wiesner, the "pangenes" of de Vries, the "idioblasts" of O. Hertwig, the "biophores" and "determinants" of Weismann, and the "factors," "determiners" and "genes" of many students of heredity. Recent studies of Men-

delian inheritance have furnished an extraordinarily complete demonstration of the existence of such inheritance units and of their persistence generation after generation. Such units are individuals in that they are separate from, though dependent upon, other units and in that they apparently manifest the fundamental vital processes of assimilation, growth and division.

2. *The Individuality of Parts of Cells.*—Many parts of a cell, such as the chromomeres, chromosomes, plastids, and in some instances at least, the centrosomes and plastosomes are also individuals in this same sense. The question of the individuality of chromosomes and centrosomes has given rise to much controversy chiefly because the term "individual" has not been clearly defined. No one doubts that chromosomes have the power of assimilation, growth and division and the only question at issue is as to whether they disintegrate at the close of every division and are formed anew at the beginning of the succeeding division. Now that individual chromosomes have been traced right through the entire resting period in several cases, there is no longer any reason to doubt that chromosomes do in some instances preserve their individuality. The fact that they, like all other forms of living matter, undergo metabolic change, receiving food substances on the one hand, and building them up into their own substance, and on the other hand, giving off the waste products of their own destructive metabolism—in short that the materials of which they are composed are undergoing continual change—does not obscure the individuality of a chromosome any more than a similar process obscures the individuality of a man. That which persists amid all metabolic changes in both the chromosome and the man is not identical atoms or molecules, but an identical organization or plan or relation of subordinate parts to one another.

In my experience the same is true of centrosomes; they also undergo growth and division, are continuous from cell generation to cell generation, and do not arise *de novo* from "cytasters," which are only temporarily isolated portions of archiplasm or kinoplasm, though they are genetically related to achromatic constituents of the nucleus. In all probabilities there are other units in the cell which preserve a like individuality, as, for example, plastids and plastosomes. All such parts of a cell have an individuality of their own, in that they are separate though not independent, and have the properties of assimilation, growth and division.

3. *Individuality of Cells.*—The individuality of ultra-microscopic units and of visible parts of cells is of a different order from that of entire cells. The former, though separate, are yet so dependent on other units as to be incapable of independent existence. In the cell for the first time we find an organic individual sufficiently independent to carry on by itself all fundamental processes of life. Protista, germ cells, embryonic cells and tissue cells show this independence in varying degrees, and yet of course, no cell and no higher organism is absolutely independent of other organisms or of the environment. In short, independence is a relative term and is no necessary part of individuality.

In the union of the egg and sperm cells in fertilization, the cells lose their independence as cells, though the separateness of parts of these cells may persist. There is here the merging of two cell individualities into one, just as in the reverse process of cell division there is the merging of one cell individuality into two. But so far as

separateness and independence are concerned, the fertilized egg cell or oosperm, and the fully formed organism into which it develops are one and the same individual, though differing greatly in complexity. This fertilized egg fuses with no other cells, it takes into itself no ready-made living substance, but manufactures its own protoplasm from food substances; it carries on its own processes of assimilation, growth and division—in short it is a separate and highly independent living thing which may be designated as an organism.

The complexity of any individual is proportional to the number of *unlike units* which constitute it, and this is as true of a chromosome as it is of a person. A common mistake is the supposition that complexity is determined by the *number* of cells, whether like or unlike, composing a body. On the other hand, as Whitman showed, the body of a one-celled protozoan may be as complex as that of a many-celled metazoan; and every zoologist knows that a mouse is as complex as an elephant, though it is composed of a much smaller number of cells. In the development of an egg cell the complexity of the entire individual increases only as the number of unlike parts increases; mere duplication of like parts leads to increase in size, but not to increase in complexity.

Only in relatively simple units is division non-differential so that both products are entirely alike, as is probably the case in all ultra-microscopic units, in cell organs and in very simple cells. In more complex individuals, whether they are cells or cell aggregates, the products of division usually differ from one another, at least when first formed, and in the most complex individuals division of the entire organism is more or less completely abandoned. In the division of a protozoan like *Paramecium* the two products are at first unlike, but as they continue to separate they become alike by a process of regulation. If these products of fission did not separate and did not undergo regulation, there would be formed a number of cells, organically connected and differing from one another in structure and function. This is just what happens in the cleavage of the egg of a metazoan; the original organism divides into many cells each of which is more or less dependent upon others. The original individual is broken up into many parts, but it is evident that there is one individual of the grade which may be called an organism at the beginning of development and just one and no more at its end; indeed the organism is the same individual from the oosperm to the end of life, irrespective of the number of cells or subordinate parts of which it may be composed. However, if cleavage cells separate and undergo regulation, as in the case of *Paramecium*, we may have as many organisms as there are separate parts. This applies to the division of groups of cells or body parts as well as to cleavage cells. If cells or parts of cells separate off which are not capable of regulation and of continued life, they do not form independent individuals.

II

If now we inquire what causes an individual of any grade to divide and thus to give rise to two new individuals we are compelled to confess that we do not know in any instance. The cause of the division of a centrosome or chromosome or nucleus or cell is as mysterious as the cause of division of a hydroid or worm. The division of the cell has been studied more fully than that of any other individual. We know that the centrosome divides before the nucleus and the latter before the cell body, but while we know that a cause must precede its effect we can not say *post hoc*

ergo propter hoc. The fact is we do not know what causes the division of a centrosome, or chromosome or cell or a many-celled organism.

Spencer held that since the volume of any organic body increases as the cube of its diameter, whereas its surface, through which it must receive nutriment, increases only as the square, it must divide after reaching maximum size in order to restore a proper ratio of surface to volume; but although this may be true in general, the sizes of cells, or of other organic bodies, vary enormously and it does not seem possible to explain all these differences in size in accordance with Spencer's hypothesis alone; furthermore, there is no indication of the mechanism by which this general need to divide actually causes division. Boveri assumed that chromosomes and nuclei grow until they are equal in size to the parent structures from which they came and that they then divide; but this is far from being true in some cases. In the cleavage of the egg the cells, nuclei, chromosomes and centrosomes progressively grow smaller, and this not at any uniform rate for all cells, some growing smaller much more rapidly than others. R. Hertwig finds the cause of cell division in the preservation of a proper ratio between the nuclear volume and the cell volume, but as I have shown there is no contant nucleus-plasma ratio since this ratio differs greatly even in different cells of the same embryo. Strassburger held that the cause of cell division was to be found in the limit of the "working sphere of the nucleus," and that when in the growth of the cell this limit was reached, the cell divided; but again it may be objected that there is no fixed limit to the "working sphere of the nucleus" even in the same animal; in some cells of *Crepidula* the volume of the nucleus at the time of division is three times that of the cytoplasm, in others the cytoplasm is fifteen times that of the nucleus. Apparently no single one of these factors is the determining cause of cell division, and it seems probable that the latter is brought on by the coincidence of several more or less independent factors.

In a series of contributions and in two recent books Child has emphasized the importance of polar "gradients of metabolism" as the basis of organic individuality. He finds, for example, that metabolism is most active at the anterior or head ends of certain protozoa, hydroids, flatworms, embryos, etc., and that it becomes less active toward the opposite ends. Regions of higher activity "dominate" those of lower activity, and whenever the metabolic activity of the head region ceases to dominate the entire body, secondary regions of higher metabolic activity appear and may lead to division, one individual thus becoming two; the basis of individuality is thus reduced to polar gradients in metabolism. But in existing organisms physiological gradients are associated with corresponding gradients in material structure, since structure and function are inseparable in living things. Disembodied functions are as unknown in biology as are disembodied spirits. Doubtless gradients of metabolism as well as of growth, division, differentiation and sensitivity exist in organisms; but there is good reason to maintain that such gradients in physiological processes are associated with corresponding gradients in material substances, and this is merely to hold that axial differentiations, both physiological and morphological, exist in organisms. That such differentiations frequently accompany the division of cells or of multicellular organisms is well known, but that they cause these divisions is unproved. The simplest individuals, such as chromo-

meres, chromosomes and centrosomes, divide into approximately equivalent halves; in many cells and cell aggregates the division halves are not equivalent, though they may later become so by regulation. It seems probable that, apart from this difference, the causes of division of all grades of individuals, from the simplest to the most complex, will be found to be similar. Individuals capable of independent existence arise either by equivalent division, as in bacteria, ameba and the germ cells of many-celled organisms, where subsequent regulation is slight, or by non-equivalent division followed by a large amount of regulation, as in the fission of many higher protozoa and metazoa. The basis of individuality in the one case is division with slight regulation, in the other division and considerable regulation.

Individuals, therefore, come into existence by the division of previously existing individuals, though it is conceivable that they may also be formed anew by the synthesis of smaller units; the former is what is known as *biogenesis*, the latter *abiogenesis*. Likewise individuals go out of existence by the division of one individual into two, with consequent loss of the original individuality, that is in reproduction, and also by the disintegration of an individual into its constituent units, namely in death.

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RESOLUTIONS IN MEMORY OF RUDOLPH AUGUST WITTHAUS AND CHARLES CLIFFORD BARROWS

THE faculty of the Cornell University Medical College has adopted memorials on the deaths of two of its members, Professor Witthaus and Professor Barrows. The memorials, which were drawn up by Warren Coleman, W. Gilman Thompson and W. M. Polk, are as follows:

In the death of Dr. Rudolph August Witthaus, emeritus professor of chemistry, on December 19, 1915, after a long illness, the medical faculty of Cornell University sustained the loss of one of its most famous men.

Dr. Witthaus was graduated from Columbia University in 1867 and received his Master's degree in 1870. He continued his studies at the Sorbonne and the Collège of France. In 1875 he obtained the degree of M.D. from the University Medical College (New York University). He occupied chairs of chemistry and toxicology, chemistry and physiology, and chemistry and physics in the universities of Vermont, Buffalo and the University Medical College (New York University). In 1898 he was called to the chair of chemistry and toxicology in Cornell University Medical College and occupied this position until his retirement, for age, in 1911. Since 1911, he had been emeritus professor of chemistry in Cornell University Medical College.

Dr. Witthaus's career was most notable perhaps for two circumstances, the eminence to which he rose and for the fact that the subject in which he acquired fame was, in his youth, the plaything of a dilettante. His interest in chemistry dated back to his college days when he converted a room in his father's stable into a laboratory where he amused himself with the study of chemical problems. Reverses in fortune soon compelled him to seek a livelihood in what had been his hobby.

In his riper years he was without a peer as a medico-legal expert. His services were often sought by the state in criminal trials involving toxicological questions and his testimony was always an important, if not the leading factor, in the verdicts of the juries. He made what is probably the most complete catalogue of reported cases of poisoning in existence.

Dr. Witthaus was a prolific, as well as a convincing, writer. His text books, "Essentials of Chemistry," "General Medical Chemistry," "Manual of Chemistry" and "Laboratory Guide in Urine Analysis and Toxicology," were much in demand and passed through numerous editions. He contributed articles on toxicological subjects to Wood's "Handbook of the Medical Sciences," and edited "Witthaus and Becker's Medical Jurisprudence" the fourth volume of which he wrote.

He was a Fellow of the American Association for the Advancement of Science and the Academy

of Medicine and other scientific bodies, including chemical societies in Paris and Berlin.

Dr. Witthaus was a man of broad culture and had many interests outside of his profession. He was an ardent disciple of Izaak Walton. His love of books amounted to a passion. At several different periods of his life he collected libraries of first and other rare editions. During his last years his chief interest lay in the collection and cataloguing of books and original manuscripts.

His fortune and medical library were bequeathed to the New York Academy of Medicine.

The faculty of Cornell University Medical College records with sorrow the death of their colleague, Dr. Charles C. Barrows, assistant professor of gynecology, which occurred on January 2, 1916, after an illness of two months.

Dr. Barrows's association with the Cornell University Medical College dates from the foundation of the college in 1898, when he was appointed clinical instructor in gynecology. He occupied this position until his promotion to the assistant professorship of gynecology in 1912. At the time of his death he had been nominated for the professorship of gynecology and he had already assumed charge of the department. The greater portion of Dr. Barrows's teaching consisted of clinical demonstrations and operations in Bellevue Hospital. Following the recent trend in medical education he introduced the system of clinical clerkships into the teaching of gynecology. Dr. Barrows was a successful as well as a popular teacher. Through his ability he excited the admiration of his students and stimulated them to put forth their best efforts; through his kindliness he made them his friends.

Except for a brief period while serving in the army, Dr. Barrows has been connected with Bellevue Hospital since 1880, when he won his appointment as interne. After his return to New York he was appointed assistant visiting gynecologist, holding this position until he became visiting gynecologist in 1915. Many of the finest traits of his character appeared in his hospital relations. He was renowned not only for his skill as diagnostician and surgeon but for his patience and poise under the most difficult circumstances. He was considerate of his subordinates at all times. No patient was too poor to claim his attention. He carried hope and encouragement to every bedside and through his skill restored many a sufferer to health and usefulness. A recent graduate of the hospital, when asked to voice the strongest impression which Dr. Barrows had made upon him, replied, "his heart was as big as the man." The loyalty of the internes serving under him was especially notable. They never speak of him except in terms of affection, and friendships formed during their hospital days grew stronger as the years advanced.

Dr. Barrows was widely known as one of New York's most skillful surgeons, and for years he enjoyed a large and successful practise. He was a member of many medical societies, was a frequent contributor to medical literature on subjects pertaining to his specialty, and devised important new surgical procedures.

SCIENTIFIC NOTES AND NEWS

ON the seventieth birthday of the distinguished Swedish mathematician, Professor M. G. Mittag-Leffler, he and his wife set aside their entire fortune for the foundation of an International Institute for pure mathematics.

THE Willard Gibbs Medal, founded by William A. Converse, of Chicago, has been awarded to Dr. Willis R. Whitney, director of the research laboratories of the General Electric Company, Schenectady, N. Y. The presentation will be made on May 19, in connection with the meeting of the Chicago Section of the American Chemical Society, when Dr. Whitney will make an address on "Incidents of Applied Research."

STUDENTS of pharmacy in the University of Pittsburgh have given a dinner in honor of Dean J. A. Koch, who has been in his present position for twenty-five years.

MR. HENRY W. FOWLER has been elected president of the Delaware Valley Ornithological Club.

SIR RICHARD A. S. REDMAYNE has been elected president of the British Institution of Mining and Metallurgy in succession to Sir Thomas K. Rose.

AT the twenty-first annual meeting of the Michigan Academy of Science held in Ann Arbor on March 28, 29 and 30, officers were elected as follows: *President,* Wm. H. Hobbs; *Vice-presidents,* Zoology, R. W. Hegner, University of Michigan; Botany, G. H. Coons, Michigan Agricultural College; Geology, L. P.

Barrett, Michigan Geological and Natural History Survey; Economics, F. A. Carlton, Albion College; Sanitary and Medical Science, H. W. Emerson, Pasteur Institute; *Secretary and Treasurer,* Richard de Zeeuw, Michigan Agricultural College; *Editor,* R. A. Smith, Michigan Geological and Natural History Survey; *Librarian,* Crystal Thompson, Museum of Zoology, University of Michigan.

WE learn from *Nature* that Second Lieutenant G. I. Taylor has been appointed to the temporary rank of major in the British Royal Flying Corps, while performing the duties of professor of meteorology. Major Taylor is a fellow of Trinity College, Cambridge, to whom the Adams prize was recently awarded. Up to the outbreak of war he held the Schuster readership of the Meteorological Office at the University of Cambridge. The professorship of meteorology to which Major Taylor is appointed is a new establishment, for which the meteorological office is responsible, for instruction and special researches in the structure of the atmosphere in the interest of the Royal Flying Corps.

SIR THOMAS H. HOLLAND, F.R.S., professor of geology and mineralogy in the University of Manchester, has been appointed chairman of a commission which the British government is forming to survey the economic resources and industrial possibilities of India.

DR. RAYMOND F. BACON, director of the Mellon Institute for Industrial Research of the University of Pittsburgh, has been appointed by the secretary of the navy as an associate member of the Naval Consulting Board and a director on the board of organization for industrial preparedness in Pennsylvania.

E. C. BINGHAM, Ph.D. (Johns Hopkins, '05), who for the past few years has been professor of chemistry in Richmond College, Richmond, Virginia, is spending the year 1915–16 in the Bureau of Standards, Washington, D. C.

CHESTER W. WASHBURNE, formerly with the United States Geological Survey, has returned to the United States after two years in the Belgian Congo where he went to prospect for oil.

THE scientific staff of the biological station of the University of Michigan, at Douglas Lake, Michigan, has been completed as follows: Director, O. C. Glaser; ornithology, R. M. Strong; vertebrate zoology and entomology, M. M. Ellis; parasitology, W. W. Cort; plant ecology, F. C. Gates; systematic botany, J. H. Ehlers; field and forest botany, R. M. Holman; assistants, R. M. Hall, M. Reynolds and C. B. Cotner.

THE Mellon Institute of the University of Pittsburgh will exchange services between its department of research in pure chemistry and the graduate departments of chemistry in other universities. Professor M. A. Rosanoff will lecture for a week at each of the other universities while a representative from that institution lectures at the Mellon Institute. Professor Harkins, of the University of Chicago, and Professor Washburn, of the University of Illinois, have arranged to go to Mellon Institute, and Professor Bogert, of Columbia University, will probably lecture at the institute later in the year.

DR. WILLIAM H. WELCH, of the Johns Hopkins University, delivered a lecture before the Book and Journal Club of the Medical and Chirurgical Faculty of Medicine, March 22, on "The Development of Medicine in the Orient."

PROFESSOR JOSEPH JASTROW, of the University of Wisconsin, addressed the Sigma Xi Society of the University of Indiana on March 28 on "The Expression of the Emotions," and delivered the Convocation address at that university on March 29 on "Theory and Practise." On March 29, he gave the Sigma Xi address at Purdue University on "The Sources of Human Nature."

PROFESSOR A. W. GOODSPEED, director of the Randal Morgan Laboratory of Physics, University of Pennsylvania, gave a series of three illustrated lectures at the Brooklyn Institute of Arts and Sciences on the X-rays on the evenings of February 25, March 3 and 10.

Dr. Harry Clary Jones, professor of chemistry in the Johns Hopkins University, died at his home in Baltimore on April 9, aged fifty-one years.

Professor Wells Woodbridge Cooke, assistant biologist of the biological survey of the Department of Agriculture, and one of the leading authorities of the United States on bird migration and distribution, died from pneumonia on March 29, aged fifty-eight years.

Frederick C. Ohm, of the petrographic division of the United States Geological Survey, died in Washington, on March 14, aged fifty-eight years.

Dr. Nathan Oppenheim, the author of several books and numerous articles on the development, the hygiene, and the diseases of the growing child, died in New York City, on April 5, aged fifty-one years.

Dr. Theodore Bernard Sachs, one of the leading workers in the antituberculosis campaign in the United States and until a few days ago superintendent of the Municipal Tuberculosis Sanatorium, Chicago, committed suicide on April 2, at the age of forty-eight years.

Mr. Geoffrey Meade-Waldo, of the entomological department of the British Museum, died on March 11, after a short illness. Mr. Meade-Waldo was the author of numerous important papers on Hymenoptera, and at the time of his death had just completed the arrangement of the bees in the museum.

Sir Alexander Russell Simpson, formerly dean of the faculty of medicine of the University of Edinburgh, died on April 6, at the age of eighty-one years.

Sir Charles Ball, regius professor of surgery in the University of Dublin, died on March 17, aged sixty-five years.

Lady Kelvin died on March 16, having survived by nine years Lord Kelvin, who died on December 17, 1907.

Dr. Eric Gerard, the director of the Montefiore Electrotechnical Institute at Liège, Belgium, and professor in the University of Liège, died in Paris, on March 27, at the age of sixty years.

The American Society of Naturalists has decided to hold its annual meeting of Convocation Week, 1916, in New York City.

The next stated meeting of the American Ornithologists' Union will be held at the Academy of Natural Sciences, at Philadelphia, from November 14 to 16.

At the invitation of the technical committee of the Affiliated Engineering Societies of Atlanta, Ga., the Bureau of Standards will hold a conference in that city on May 2, 3 and 4, for the purpose of discussing the work of the bureau in connection with the national electrical safety code and the prevention of electrolysis of gas and water pipes, cable sheaths and other metallic underground structures.

The Puget Sound Marine Station will open its session at Friday Harbor, Wash., on June 26, 1916, and continue for six weeks. The teaching staff will consist of the following: Dr. T. C. Frye, University of Washington; Dr. H. S. Brode, Whitman College; Dr. Nathan Fasten, University of Washington; Dr. H. J. Van Cleave, University of Illinois; Mr. W. L. C. Muenscher, Sioux Falls, South Dakota; Mr. A. C. Jensen, Mt. Pleasant, Utah; Miss Edna M. Perry, Bellingham, Washington; Miss Annie May Hurd, Seattle, Washington; Mr. G. C. Woods, Walla Walla, Washington. The total expense for the six weeks is about $50. Those east of the Missouri River may add to the pleasure of the trip by joining Professor H. J. Van Cleave's party from the University of Illinois.

The United States Biological Laboratory, Fairport, Iowa, will be open to temporary investigators on June 15. While the laboratory is open the entire year, the mess and other special accommodations for summer workers will not be available until this date. The equipment and facilities of the station provide excellent opportunities for biological investigations of a general and specific nature, with particular reference to freshwater forms, and also for chemical and physical studies

relating to biological problems. Opportunities are especially good for studies relating to fish and mussels. Investigators desiring to occupy tables for the whole or part of the season should communicate with the commissioner of fisheries, Washington, D. C., or the director of the station.

THE *Experimental Station Record* states that four new Canadian entomological laboratories were completed during the summer of 1915, located respectively at Annapolis Royal, Nova Scotia; Frederickton, New Brunswick; Treesbank, Manitoba; and Lethbridge, Alberta. The laboratory at Frederickton is the most elaborate of these structures and is a two-story and basement brick building 24 by 30 feet, located on the campus of the University of New Brunswick. Its work has been especially directed toward the natural control of insects, notably the brown-tail moth, tent caterpillar, spruce budworm and fall webworm. The laboratory at Annapolis Royal is a wooden one-story and basement building, 26 feet square. It is located on the county school grounds and is equipped with special reference to combating the brown-tail moth and for studies of the bud moth, fruit worm and other fruit pests. It replaces a former temporary laboratory at Bridgetown, which is to be used as a substation wherever most needed. The laboratories at Treesbank and Lethbridge are of the bungalow type, the former being 12 by 16, and the latter, located on the Dominion substation farm, 23 by 20 feet.

AT the University of Chicago a contract has been made with the United States Department of Agriculture for the establishment in Julius Rosenwald Hall of a meteorological observatory of the United States Weather Bureau. Instruments for observation are to be placed upon the roof of the tower, and instruments for registering seismic disturbances and for other purposes of the bureau are to be installed in the building. Rain gauges and a thermometer shelter are to be placed on the campus. By the terms of the contract the faculty and students of the university may have free access, within reasonable limits, to the records of observations made and of data gathered; and printed matter containing the results of investigations based upon observations made in this observatory will show the cooperation of the university with the department.

WE learn from the *Auk* that Mr. W. Leon Dawson, of Santa Barbara, Cal., has made over his valuable collection of birds' eggs and nests to a board of trustees who are incorporating an institution to be known as the Museum of Comparative Oology, in which it is hoped to accumulate a representative collection of the nests and eggs of the birds of the world. Mr. Dawson is to have responsible control of the collection during his life in order to insure its proper care during the early years of the enterprise. At the expiration of three years, during which he will be engaged in field work in connection with the forthcoming "Birds of California," a campaign will be inaugurated for an endowment and a group of buildings suitable for housing the collection. A number of prominent oologists and ornithologists have been invited to form a board of visitors to cooperate with the museum management.

THE trustees of the National Dental Association have purchased a large private residence in Cleveland, O., as temporary quarters for a new Research Institute until adequate buildings can be erected. The Research Institute is supported entirely by the association, and the plan of organization is a corporation with a membership of sixty, twenty-seven of whom are elected by the trustees of the National Dental Association and known as commission members, and thirty-three are permanent members and are selected by the corporation. The board of nine trustees has chief responsibility for the conducting of the work in the institution and carried on under grants. They are assisted by an advisory board of eighteen. It is said to be the first institution of its kind in the world. Various problems contemplated for study are: Pyorrhea, dental caries, mouth infections, relation of baby foods to tooth structure, relation of glands of internal secretion to defective tooth structure, staining of teeth, etc. Part of the work will

be the collecting and distribution of information for educational work, particularly for the medical and dental professions. The present officers are: Dr. W. A. Price, Cleveland, president and managing director; Dr. Thos. P. Hinman, Atlanta, vice-president; Dr. Clarence J. Grives, Baltimore, secretary; Lefa A. Beman, Cleveland, assistant secretary; Edward A. Petrequin, Cleveland, treasurer. The trustees are: Dr. Weston A. Price, Cleveland, Harry J. Crawford, Cleveland, Dr. John V. Petrequin, Esq., Cleveland, Dr. Geo. W. Crile, Cleveland, Dr. Clarence J. Grives, Baltimore, Dr. Eugene R. Warner, Denver, Dr. Thos. P. Hinman, Atlanta, Edward A. Couzett, Dubuque, Iowa, and Dr. Homer C. Brown, Columbus, O.

THE Anglers Association of Onondaga, of Syracuse, N. Y., one of the largest associations of the kind in New York State, and the New York State College of Forestry at Syracuse, have decided upon a cooperative plan for the utilization of the fine springs at the college nursery as a trout nursery and for fish ponds. The college furnishes the site and the anglers pay for the man to care for the fish, etc. The general plan is to care for the young trout fingerlings, received from the Conservation Commission in the spring, and to carry them over the summer in this nursery and then plant them in the fall, at a more favorable season and in better condition. This is the practise now so successfully followed at Rome, N. Y., under the leadership of Mr. Harry Ackley, president of the Rome Fish and Game Association. The fish nursery and ponds will be available to the college for the instruction of its students in the course on fish and game taught to forestry students by Dr. C. C. Adams.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of California has received the following gifts and subscriptions toward the equipment of the new 216-bed University Hospital (now being built in San Francisco from gifts of over $600,000): Mrs. James Moffitt, $5,000; an alumnus, $5,000; Mr. Alexander F. Morrison, $5,000; Mr. William H. Crocker, $2,616.50; Mr. Wallace M. Alexander, $2,000; a friend of the university, $2,000; Mr. N. Ohlandt, $1,500; Mr. Charles W. Merrill, $1,000; Mr. D. C. Jackling, $1,000; and the children of the late F. W. Dohrmann, $500.

THE bill of the ways and means committee in the House of Representatives of the Maryland Legislature makes the appropriation of the state to Johns Hopkins University $50,000, a decrease of $25,000 from the grant of last year.

PROFESSOR WILBUR L. CROSS, graduate of the English department of the Sheffield Scientific School, has been elected by the faculty of Yale University to be dean of the graduate school. He succeeds Professor Hans Oertel, who is now in Germany.

IVEY F. LEWIS, Ph.D. (Johns Hopkins, '08), fromerly professor of botany in the University of Missouri, has gone to the University of Virginia as professor and head of the Miller School of Biology.

MR. A. W. DUPLER, of the University of Chicago, has been elected professor of botany at Lawrence College, Appleton, Wisconsin. Dr. R. C. Mullinix, who has been head of the department of biology, will continue as professor of zoology.

MR. GEORGE F. MOZNETTE has been appointed as assistant professor in entomology at the Oregon Agricultural College and Station to begin his duties on March 1.

PROFESSOR ETTORE MARCHIAFAVA, a senator of the kingdom of Italy, known for his work on malaria and in other directions, has been appointed to the chair of clinical medicine at Rome left vacant by the death of Professor Guido Baccelli.

DISCUSSION AND CORRESPONDENCE

HORIZON OF THE SHARK RIVER (N. J.) EOCENE DEPOSITS

SOME twenty-five years ago, while working over the Eocene molluscan material in the

Smithsonian Institution from the so-called Pamunkey of Maryland and Virginia, it became perfectly evident to the writer that the majority of the species were very similar to, or identical with, the more common species from the lower "Lignitic" or Bell's Landing horizon of Alabama.[1] Shortly afterwards he observed other specimens while on a trip in southern Virginia representing a higher "*Sellæformis*" horizon. All these faunas have since been ably worked up by members of the Maryland Geological Survey.[2]

Away to the northeast, but seemingly quite in the general line of outcrop of the Maryland Eocene, are the Shark River beds with a poorly preserved yet interesting fauna. Opinions of Conrad, Cook, Heilprin and Clark have varied as to whether these beds should be referred to the horizon of the near-by Marylandian deposits or should be relegated to a still older Eocene stage. The writer, however, has been quoted on several occasions[3] as believing that the Shark River beds should be placed above the general horizon of the Pamunkey Eocene, within a Mid- or Upper Eocene stage.

Since the data upon which this belief is founded have not been made known, it seems quite proper to place them on record that their validity may be intelligently discussed.

It may accordingly be noted:

1. That the absence of such characteristic Pamunkey species as *Ostrea compressirostra, Cucullæa gigantea, Dosiniopsis lenticularis, Crassatella alæformis* and huge *Turritellæ* and *Venericardiæ* seems to preclude the synchronizing of the Pamunkey and Shark River deposits.

2. That the Shark River beds are not *below* the Pamunkey beds from: (*a*) The fact that if they were they would naturally be the equivalent of some basal or Midway Eocene horizon. Certainly if such were the case there should be some trace in the Shark River beds of that great virile Midway fauna that stretches from the Carolinas to the Rio Grande, on the north, and from Trinidad to east of Brazil, on the south; the similarity should be as great between Shark River beds and Alabama Midway as between Pamunkey and Bell's Landing beds —in fact the "Lignitic" beds are more local in character than the more truly marine Midway. But the Pamunkey shows derivatives of the Midwayan in its *Hercoglossa, Cucullææ* and great *Turritellæ,* while these striking forms are absent from the Shark River deposits. (*b*) The fact that, as indicated above, if these beds are pre-Pamunkey they must also be pre-Midway, *i. e.,* older than the oldest known marine Eocene on this continent, which seems quite out of the question.

3. That the Shark River beds are Mid-Upper Eocene and above perhaps all of the Pamunkey horizons from: (*a*) The fact that the general aspect of the molluscan fauna is upper and not lower Eocene. Witness the presence of *Aturia* and not *Hercoglossa;* the large rotund *Caricellæ* closely allied to, if not identical with, the Claibornian forms showing nothing in common with the small slender Midway species; the *Fusoficula* of *penita* proportions and appearance and not of the older *juvenis* type; *Turritellæ* of non-carinate, Claibornian aspect; *Pleurotomariæ* of huge dimensions as in the Upper Eocene beds of the Carolinas though unknown in lower horizons; *Ostreæ* of the Claibornian *divaricata* (*i. e., sellæformis*) type and with nothing in common with *crenulimarginata* of the Midway or *compressirostra* of the Lignitic; *Pectens* of the types found in the Claiborne and Pope's Creek beds, with no resemblance to those of earlier horizons; *Crassatellæ* of the high, huge *alta* type of the Claibornian, with nothing in common with the lower Eocene forms; *Volutilithes,* similar or identical with Claibornian forms and without the *Athleta* characteristic of the Lignitic. (*b*) The fact that the coral from the Shark River beds noted by Vaughan is of a genus unknown from any other state "from a horizon below the Claibornian."[4] (*c*) The fact that although the vertebrate evidence on this question is very slight, "*Anchip-*

[1] *A. J. S.,* Vol. 47, p. 301.

[2] See especially Rept. '01, Eocene.

[3] Mon. 39, U. S. G. S., p. 17.

[4] *Op. cit.,* p. 17.

podus riparius is currently identified with *Trogosus* or *Tillotherium* of the Bridger Middle Eocene. If this identification is correct and if it came from the Shark River beds, then these are probably Middle Eocene, possibly later, but not earlier."[5] (*d*) The fact that the Pamunkey embayment or segment filled in seaward during Eocene time till the Carolina end of the arc was reached in late Eocene times, would suggest a similar age for the New Jersey beds at the other end of the arc.

The conclusions from the above outline of facts may be thus briefly summarized:

(*a*) The Eocene beds in New Jersey may be in the same trend of the Maryland Eocene outcrops, but this fact has little to do with the relative age of the deposits.

(*b*) The known Shark River fauna shows very little relationship with the comparatively near-lying Pamunkey faunas; still less with any known lower or basal Eocene, Midway fauna.

(*c*) The general aspect of the Shark River fauna with its many species closely allied to or identical with Claibornian forms would seem quite sufficient in itself to cause these New Jersey beds to be referred to a horizon *above* instead of *below* the mass of Pamunkey deposits.

(*d*) Data from other paleontologic sources are of a questionable nature, but so far as they go they seem to support the writer's contention.

Gilbert D. Harris
Paleontological Laboratory,
Cornell University,
Ithaca, N. Y.

A PHYTOPHTHORA ON OATS

While in the recently started experiment garden at Stanford University on February 10, I noticed on the leaves of volunteer oats markings such as I had not seen before.

On examining the material in the laboratory, the markings were found to be due to a species of *Phytophthora*. The markings may appear as spots or as stripes along one or both margins of the leaf, or as a stripe down the center. The diseased areas become yellowish, and then whitish when conidia are abundant. Later these areas, which sometimes have a water-soaked appearance, become brown or reddish-brown, and the parts shrivel and dry up.

The short, hyaline, unbranched conidiophores (4–5 × 15–300 μ) issue from the stomata on both sides of the leaves and usually bear a single ovate or obpyriform conidium. The conidia are quite large (30–42 × 42–78 μ, occasionally one is much smaller) and fall away with a small part of the conidiophore attached. They germinate by producing numerous zoospores. Chlamydospores were found crowded together in the tissues of some of the older diseased areas. They were globular, hyaline or very light yellow, some thin-walled and others thick-walled, and 12–18 μ in diameter. In some leaves oospores were also found abundantly. The oogonia were thin-walled and 30–39 μ in diameter. The globular oospores were 27–30 μ in diameter, the epispore being smooth, hyaline or light yellow, and about 2 μ thick.

The species is certainly very similar to *Phytophthora Colocasiæ* Rac. on the taro (*Colocasia esculenta*) in Java, India and Formosa, but a more extended study is necessary to determine its specific rank. It has been found in several fields about Stanford University and by the state highway near Mayfield, California. As a large percentage of the plants were infected in some localities, the fungus may become of considerable economic importance.

James McMurphy
Stanford University,
February 17, 1916

ENDURANCE OF THE PORPOISE IN CAPTIVITY

The New York Aquarium lost last year a most attractive exhibit, the bottle-nosed porpoise (*Tursiops truncatus*) which has lived in the large central pool of the building for more than twenty-one months.

The cause of its death was a mixed infection, which in a few days attacked every part of its skin, covering the smooth glistening surface with unsightly pustules. This infection

[5] Matthew, *ex lit.*

was clearly the result of keeping the animal in water pumped from New York Harbor, the only supply available for the large floor pools, under present conditions.

The water of the harbor is always of low salinity and is charged with sewage, its foulness being especially noticeable in midsummer.

The propoise had grown perceptibly since its arrival on November 15, 1913. Its weight at death was 293 pounds and its length eight feet. Four other porpoises received at the same time lived seven months in captivity, when they died of pneumonia in rapid succession.

Like the one referred to above their skins at death were also filth-infected, although not to the same extent. Our experience has shown that the porpoise readily endures captivity and might live much longer if pure sea water were available. Other porpoises will be obtained and equipment is now being installed for filtering the harbor water—an improvement that has long been needed at the Aquarium.

The school of porpoises contained both sexes and they were often observed mating. The loss of the females was especially disappointing as the prospects for breeding in captivity were promising.

All of these porpoises were constantly active and playful to within a few days of their deaths.

C. H. TOWNSEND
THE NEW YORK AQUARIUM

SCIENTIFIC BOOKS

A Treatise on Light. By R. A. HOUSTOUN, Lecturer on Physical Optics, University of Glasgow. Longmans, Green and Co., 1915. Pp. 478. $2.25 net.

To the student of optics familiar with the treatises of Drude, Preston, Shuster and Wood, and numerous other text and reference books on optics, there would appear to be little need for a new text in this field. Professor Houstoun's treatise is, however, unique in scope and treatment, and will doubtless prove of great value both as a text and for reference.

In scope, this treatise covers both theoretical and physical optics, together with geometrical optics, vision, photometry, illumination, spectroscopy and X-rays. Part I. deals with Geometrical Optics, Part II. with Physical Optics, Part III. with Spectroscopy and Photometry and Part IV. with Mathematical Theory. An extremely concise treatment of each subject makes it possible to cover this wide field in so few pages, the style is lucid and free from unnecessary explanation and deductions. Except, perhaps, in the chapter on the nature of light, the treatment is nowhere exhaustive or profound, and is well adapted to the use of advanced undergraduate students.

Part I., on Geometrical Optics, deals in seven chapters with the elementary theory of image formation, the theory of the simple optical instruments and the determination of refractive indices. The third order defects of images (Seidel aberrations) are barely mentioned. This section of the book, while an excellent teaching text in that it presents a well-balanced outline of the subject, would be much more valuable if it included a little modern technical optics dealing with lens calculation, the third-order aberrations and precise methods of testing.

The hundred pages on Physical Optics is a discussion of the velocity, interference, diffraction and polarization of light in six chapters. A rather full treatment of the diffraction grating is given, but otherwise the matter presented is quite academic and very concise. On page 190 statements (3) and (4) regarding interference between two beams of plane polarized light evidently require revision. The description of improved polarizers and analyzers does not mention those devised by Brace and used with such success by his students.

Part III., entitled Spectroscopy and Photometry, contains two chapters on the spectroscopy of the visible spectrum, a chapter on the ultra-violet and one on the infra-red and X-rays. The remaining three chapters are devoted to Photometry and Spectrophotometry, the Eye and Color Vision and Lamps and Illumination.

The two chapters on general spectroscopy, for their length, could hardly be improved upon in choice and presentation of material. The chapter on the ultra-violet impresses the re-

viewer as rather meager, many of the more important phenomena connected with ultra-violet light not being mentioned. The same criticism might be made of the chapter on the infra-red spectrum which includes a page on cathode rays and four pages on X-rays. The three chapters on photometry, illumination and the eye are the least satisfactory in the whole book. The treatment is academic, scanty and contains little that is valuable and modern, but it is a decided advance to include these subjects at all in a general text on light.

Part IV., on the mathematical theory of light, gives an excellent presentation of the electromagnetic theory in six chapters totaling one hundred pages. The opening chapter on the nature of light, giving the gist of a number of the author's papers on the subject, needs no apology on the ground that it is original material. The final chapter is on the relative motion of matter and ether.

Numerous problems are given at the end of each chapter. These and the general presentation and arrangement of matter make the treatise well adapted for class-room work for third year students in the average university. If supplemented by a little modern technical optics it would serve very well as an introduction to applied optics.

P. G. Nutting

Rochester, N. Y.

John Shaw Billings. A Memoir. By Fielding H. Garrison, M.D. New York and London, George P. Putnam's Sons, 1915. Pp. 432.

I was first brought into contact with Dr. Billings in the Satterlee Army Hospital, Philadelphia. He was the executive officer and not long after my being ordered there I was appointed assistant executive officer. This threw us much together. One evening in his quarters he became unusually free and confidential in his conversation and in an infrequently interrupted monologue he told me in detail the story of his early life and trials. These are sufficiently set forth in this admirable volume. That one could overcome such obstacles and finally reach the international fame which crowned his later life is an inspiring lesson to every young man and especially every young doctor.

The last time I saw him was not long before his death. He took the time to show me all over his latest triumph, the New York Public Library.

Before he was fifteen he bought a Latin grammar and dictionary in order to translate the classical quotations encountered in his always omnivorous reading. With a geometry, some Greek books, etc., he eked out his knowledge sufficiently to enter Miami University, graduating in arts in 1857 and in 1859 in medicine. His early struggles with poverty (during one winter he lived on 75 cents a week) were much lightened by his becoming demonstrator of anatomy in 1860.

In 1861 he began his wonderful career first as an army surgeon. His remarkable powers of work and of organization were at once called into play. This was the first phase in his professional life. From the field he was sent to the surgeon general's office. In this new sphere he soon became the first medical bibliographer not only of our time, but of all time. I remember seeing him more than once flanked right and left by two appalling piles of journals checking title after title for cataloging. The result was year after year the great Index Catalogue of the Surgeon General's Library and later the Index Medicus, the two greatest contributions ever made to medical bibliography.

These two services in the field and in the library, with much labor in the museum, would be enough for most men. But he added a third career in sanitation and hospital construction. In the course of his life he planned seven great buildings, the Johns Hopkins Hospital being the first and the New York Public Library the last. While as Dr. Hurd has pointed out the "housekeeping" part of that hospital was not perfect, yet we must remember that even Jupiter sometimes nods. In one of these somnolent spells Billings actually used candelabræ as a plural.

As a statistician and scientist he won a prominent place. His address in 1881 at the International Medical Congress and in 1886

at the British Medical Association were veritable triumphs.

His final seventeen years at the New York Public Library were the culmination of his laborious and distinguished life.

Samuel D. Gross, Weir Mitchell and Billings were by all odds the most widely known American medical men in the last half of the nineteenth century.

Dr. Garrison's book is delightful. He is judicious in his selection from Billings's Letter and Addresses. His style and his general review of the various stages of Billings's development and of his character and personality leave nothing to be desired. The only regret I have is that he takes as I think a backward step in using the archaic and souperfluous "u" in labour, endeavour and their similars.

W. W. KEEN

SPECIAL ARTICLES

EFFECT OF COLORED LIGHT ON THE MOSAIC DISEASE OF TOBACCO

IN connection with extended work on the mosaic disease of tobacco in this section of the Connecticut Valley, it was found that plants grown under shade or tents appeared to be much less affected with the mosaic disease than those grown in the open. This fact had previously been noted by Sturgis[1] in Connecticut, and the writer, in conjunction with other work on this disease, outlined experiments relative to a study of light conditions on the intensification or reduction of the disease.

While the writer's preliminary work was in progress, his attention was called to a paper by Lodewijks[2] published in 1910, which dealt with the effects of colored light on mosaic diseased plants. As a result of his experiments Lodewijks stated that a cure was effected by blue light; red light diminished the disease, and suffused light checked it somewhat. This is not the place for an extended discussion of his methods of experimentation, but in brief it may be stated that the diseased leaves of the plant were enclosed in a cloth hood of the desired color, the apparently healthy basal leaves remaining uncovered and exposed to normal daylight. After some time the hoods were removed and the plants examined for symptoms of the mosaic disease. The results obtained, if substantiated, would be of great interest and value. In order to satisfy himself the writer duplicated in so far as was possible the work of Lodewijks, employing the same methods and cloth hoods of approximately the same texture as those used by him in his experiments. The hoods were allowed to remain over the plants for thirty days; at the end of this period they were removed and the plants carefully examined for visible symptoms of the disease. The results obtained were in brief as follows:

The plants covered with the red cloth hoods showed a diminished color variation between the light and dark green areas of the diseased leaves, and all new growth showed a more or less pronounced mottling. After remaining a week exposed to normal daylight, all the new growth was badly diseased. Healthy plants inoculated with juice from the treated leaves became diseased in from ten days to two weeks. Control inoculation remained healthy. From the above results it may be stated that there is a diminution in color variation in diseased leaves, not of a permanent character, however, and the active principle of the disease remains very virile and highly infectious.

Similar experiments carried on with blue cloth hoods gave the following results: On three plants after thirty days' treatment no visible symptoms of the mosaic disease were observable, although there was a slight tendency towards curling noticeable on a few leaves of the new growth. One other plant, however, showed a slight mottling on two of the young leaves. Two weeks after the hoods were removed, the first three plants did not show any marked symptoms of the mosaic disease other than a faint mottling of a few

[1] Sturgis, W. C., "On the Effects on Tobacco of Shading and the Application of Lime," Conn. Agr. Exp. Sta. Ann. Rept. 23: 252–61, 1899.

[2] Lodewijks, J. A., Jr., Zur Mosaikkrankheit des Tabaks. Rec. Trav. Neerlandais, Vol. 7, 107–29, 1910.

leaves. The fourth plant developed mosaic again, but not as seriously as before treatment. Healthy plants inoculated with the juice of leaves from the first three plants contracted the disease almost without exception, as they did from the fourth plant, which showed the disease. Here we have a case of *apparent* recovery, but the plants still contained the active principle of the disease in a very infectious form. The percentage of infection from these plants is given below:

From plant No. 1, 8 healthy plants developed 6 cases of mosaic in 18 days, 75 per cent.

From plant No. 2, 8 healthy plants developed 8 cases of mosaic, or 100 per cent.

From plant No. 3, 10 healthy plants developed 9 cases, or 90 per cent.

From plant No. 4, which showed a slight trace of the mosaic, 100 per cent. infection was secured.

These results show that when blue light is used, there is a suppression of the leaf color variation more or less permanent in character, the treated plants with one exception showing no typical symptoms of the disease for at least two weeks subsequent to the removal of the hoods. It can not be said, however, that the disease was controlled, as inoculation of healthy plants with juice from diseased leaves produced the trouble in nearly every case. The active principle of the disease was still present in apparently normal, fully recovered leaves, and was highly infectious.

These experiments were repeated and the same results obtained in practically every case. They do not entirely harmonize with the results obtained by Lodewijks, but do in so far as the plants under the blue hoods showed an *apparent* recovery; but as Lodewijks, so far as the writer is aware, did not try any reinoculation experiments, he overlooked the fact that the active principle might still be contained in the leaves and that it might be capable of transmission. This is clearly shown in the above experiments, and there is no doubt that the active principle of the disease is still present in plants treated in this manner. It is evident that the treatment of plants as above recorded does not destroy the active principle, whatever may be its character, the treated leaves apparently still containing it, very probably in the same manner as do parts of the plant which do not show visible symptoms of the disease normally, such as the stem, lower leaves and roots—the juices of which are often highly infectious.

More detailed results of these experiments are to be published later in connection with a report of work on the mosaic disease of tobacco as carried on at this station.

George H. Chapman
Massachusetts Agricultural
Experiment Station

THE NATIONAL ACADEMY OF SCIENCES

At the annual meeting of the Academy to be held on April 17, 18 and 19, the program of the scientific sessions will be as follows:

Auditorium, National Museum. Public scientific session for the reading of papers.

On Permeability of Endothelia: S. J. Meltzer.

The Influence of Morphin upon the Elimination of Intravenously Injected Dextrose: I. S. Kleiner and S. J. Meltzer.

The Sex of a Parthenogenetic Frog: Jacques Loeb.

It seemed of interest to determine the sex of frogs produced by artificial parthenogenesis. The first experiments in this direction by Loeb and Bancroft had been made on a frog and a tadpole of about four months old. The gonads of both sexes contain eggs at that age and it was only with approximate certainty that the sex of our parthenogenetic specimens could be determined. As far as we were able to judge the sex in the two cases referred to was male. The writer has since succeeded in keeping a number of parthenogenetic frogs alive for about one year and one of them was recently killed and the gonads sectioned and examined. They were found to be testicles containing well-developed spermatozoa. This confirms the former statement of Loeb and Bancroft that the frogs produced by artificial parthenogenesis are males.

Finer Mechanisms of Protection from Infection: Simon Flexner.

The biological phenomena associated with recovery from bacterial infections among animals remained largely unexplained until the era which

CLIVE... OF... COLLEGE

ushered in the antitoxic treatment of certain bacterial diseases and notably diphtheria and tetanus. Since then, data have accumulated rapidly. No difficulty is encountered in explaining antitoxic immunity, so called, which is a process essentially of neutralization—of a toxic body with the antitoxic antagonist. But no such simple explanation suffices to account for the process through which living bacteria and not their waste products alone are destroyed. Several independent reactions are distinguishable: the assembling (agglutination) of the bacteria, their englobing by cells (phagocytosis), and their disintegration inside and outside of cells (bacteriolysis). The processes are partly inherent in the animal host, partly subject to augmentation. The experiments to be described deal with the finer mechanism of the disposal of bacteria through phagocytic activity and the action upon the mechanism of antiseptic chemicals which have been or conceivably may be recommended for the treatment of the bacterial infections because of the possession of bactericidal properties.

The Distribution of the Chondriosomes to the Spermatozoa in Scorpions: EDMUND B. WILSON.

The spermatozoon carries into the egg two kinds of bodies that have been supposed to play a definite part in heredity; these are the chromosomes and the chondriosomes, the former belonging to the nucleus, the latter to the protoplasm or cytoplasm. The chromosomes (with certain specific exceptions) undergo in general an accurately equal distribution to the germ-cells; whether this is also true of the chondriosomes is not certainly known, though an approximately equal distribution undoubtedly occurs in some cases. In the Arizona scorpion, alone among animals thus far examined, an accurate quantitative distribution of the chondriosome-material may be demonstrated owing to the fact that prior to the spermatocyte-divisions all this material becomes concentrated in a single, definite body in the form of a ring. This body, a new type of chondriosome, divides somewhat after the fashion of a heterotype chromosome-ring, each spermatid receiving exactly one fourth of its substance. In the California scorpion the phenomena offer a remarkable contrast to this, agreeing in the main with the European form *Euscorpius carpathicus* as described by Sokolow. The ring is here absent, its place being taken by about 24 separate, hollow spheroidal bodies that show no evidence of division at any time and establish no definite relation to the spindle, but are passively segregated by the spermatocyte-divisions into four approximately equal groups. Each spermatid thus receives as a rule six, not uncommonly five, rarely seven of these bodies, which give rise to the nebenkern like the products of the ring in the Arizona form. In both cases the chondriosome-material has the same origin, seems to play the same part in the formation of the spermatozoon (nebenkern, envelope of the flagellum) and shows the same staining reactions (Benda method). Interesting questions are thus raised concerning the principle of genetic continuity as applied to the chondriosomes or to other specific cell-components.

Further Studies of the Protein Poison: VICTOR C. VAUGHAN.

In 1903 Wheeler and I discovered a poisonous group in the protein molecule. This work has been extended by my students and myself and confirmed by others. Since my latest publication on this subject, the following new facts have been discovered in my laboratory: (1) *Skin Reaction.*—When a drop of an aqueous solution of the poison is placed on the normal skin and the epidermis covered by the drop abraded, there results a local inflammatory process. Within a few minutes the skin about the point becomes edematous, resembling a hive, and later develops a redness which gradually fades. This reaction is similar to the specific reactions which may be developed in certain diseases and develops in the skin of normal individuals because the poison has already been set free in vitro. (2) *Absorption from the Alimentary Canal.*—I have stated that the protein poison is harmless when taken by the mouth for two reasons: (1) it is broken into harmless groups by the digestive ferments and (2) it diffuses through the intestinal walls too slowly to have any deleterious effect. We have found that when given in relatively large amounts, especially on an empty stomach, the protein poison may be absorbed in sufficient quantity to cause death from either acute or chronic intoxication. In the latter, a typical and marked fatty degeneration of the liver and kidneys results. Moreover, we have demonstrated that in both acute and chronic intoxication the poison may be detected in the liver, kidneys, lungs, brain and other tissues. It can be extracted and its action demonstrated by intravenous injection in guinea-pigs. (3) *Combination with Proteins.*—The protein poison combines with certain proteins and in these combinations the acidity of the poison and its toxicity are modified.

SYMPOSIUM ON THE EXPLORATION OF THE PACIFIC

Arranged by W. M. Davis

(By invitation of the Program Committee)

On Exploration of the Pacific: W. M. Davis.

The unsolved problems of the Pacific can not be settled by a continuation of independent and short-lived explorations, such as have heretofore been undertaken. Future work should be broadly areal, rather than local as on single islands, or linear as in single voyages. It should be continuous through ten or twenty years, so that its scientific directors may repeatedly inspect the uncertain elements of their work, and thus gain in the earlier years the expertness necessary for the critical study of the most difficult problems through the later years of their explorations. The type of investigation needed in various branches of science is furnished by the repeated traverses of the Pacific on many interwoven routes in the course of the magnetic survey of the earth by the Carnegie Institution of Washington. Problems of a century or more ago were bravely attacked in adventurous voyages of discovery. Problems of a generation ago were earnestly approached by less adventurous and more scientific voyages of investigation. But the demands of modern science have become exacting. So delicate are the variations of temperature and density in ocean water at various depths, so elaborate are the phenomena of oceanic and atmospheric circulation, so complicated are the details of shoreline features by which changes in the level of the land or reversed changes in the level of the ocean are to be inferred, so involved are the biological problems of pelagic islands, that the detached facts of earlier scientific voyages must now be supplemented by more continuous bodies of facts. The development of a comprehensive plan for the exploration of the Pacific is worthy of the National Academy of Sciences, and it is to be hoped that the commendation of such a plan by the Academy may lead in the next five or ten years to its realization.

The Importance of Gravity Observations at Sea in the Pacific: J. F. Hayford.

A New Method of Determining Gravity at Sea: L. J. Briggs.

The method employed in measuring g at sea consisted in observing the height of a mercurial column in vacuo necessary to maintain a confined mass of gas at a constant volume when kept at a constant temperature. The mercurial column is contained in a capillary glass tube bent into a zigzag or spiral above the gas chamber, and expanding at the top of the capillary into an evacuated observing bulb which contains a fixed iron point. The capillary tube is sealed through the upper end of the gas chamber, the lower end of the capillary tube dipping beneath mercury in the bottom of the chamber. The pressure of the nitrogen in the gas chamber (about 72 cm.) is so adjusted that at the temperature of melting ice the mercury surface at the top of the column is in contact with the fixed point at the center of the evacuated bulb. The gas chamber is then sealed. The zigzag in the glass capillary makes it possible to raise or lower the observing bulb slightly with reference to the gas chamber, the motion being controlled by a micrometer screw mounted on the gas chamber. In making an observation, the apparatus is adjusted to a vertical position in a bath of melting ice, and the observing bulb is raised or lowered until the mercury is in grazing contact with the fixed point. Under these conditions the quantity of mercury in the observing bulb is always the same, so that the quantity of mercury in the gas chamber is also constant. The gas volume is therefore constant and the measurements are made at constant pressure. The relative value of g at two stations is therefore inversely proportional to the height of the mercurial column at these stations. The height is represented by the micrometer reading plus a constant term determined from a manometer connected with the gas chamber at the time of sealing. On shipboard the ice tank is hung in gimbals which are suspended from spiral springs. The apparatus has been used in measurements from Sydney to San Francisco, and from New York to San Francisco, via Panama. The mean probable error of observations at base stations during the latter voyage, in which three instruments were used, was 1 part in 60,000. Apparent anomalies were observed at sea on both sides of the Isthmus of Panama, along the coast of Lower California and off the California coast near San Francisco.

The Problem of Continental Fracturing and Diastrophism in Oceanica: C. Schuchert.

A presentation of the problems connected with Oceanica, the most mobile region of the Pacific Ocean, and with the fracturing and foundering of Australasia within the area.

Petrological Problems in the Pacific: J. P. Iddings.

A number of geological problems of the first magnitude are also petrological ones since they involve the material of the lithosphere, which is only known through a study of the rocks.

Throughout the vast extent of the Pacific Ocean scattered volcanic islands furnish us with material evidence of the composition of the suboceanic portions of the lithosphere. A thorough investigation of the rocks of these islands will contribute to our knowledge of the distribution of various igneous rocks, that is, to the problem of petrographical provinces which involves the question of lateral heterogeneity of the earth.

Closely allied to this is the problem of isostacy, or the relation between the major features of the relief on the earth's surface and the density of the underlying lithosphere. Igneous rocks from continental regions should average lighter than those from deep oceanic regions. Preliminary estimates appear to confirm this expectation, but much more data regarding the rocks of deep sea islands are needed to establish the relationship.

An exhaustive study of the rocks of the Pacific islands will determine the character of each group as either the summits of volcanoes built up from the sea bottom or partly submerged remnants of a former continental area.

Afternoon Session

2.30–6.00 P.M.—Auditorium, National Museum.

A New Form of Metamorphism: ARTHUR KEITH (introduced by GEORGE F. BECKER).

Many Appalachian rocks are known which appear to be massive plutonics and have been called quartz diorite. Some evidence against this was known from the first, but their metamorphic nature is now considered settled. These rocks form bodies with shapes usually somewhat elliptical, but also lenticular, in sheets or dike-like masses. Their larger relations are: (1) gradation into the enclosing rocks; (2) occurrence only in graywacke or similar rocks; (3) thickness, rarely over three feet; (4) lack of igneous rock in the same region; (5) presence at many horizons; (6) occurrence over thousands of square miles. The principal minerals are quartz, hornblende or biotite, garnet, albite and oligoclase, the most conspicuous being hornblende, biotite and garnet. These obliterate the older minerals, and their prisms are disposed at random in marked contrast with the older parallel structures. The most striking assemblage is a spheroid composed of concentric shells of different mineral contents. These rocks were metamorphosed from graywacke or similar rock under heat and pressure but no movement. They raise anew the old question of the formation of igneous rocks from sediments. It appears, however, that they were not fused as a mass, but that their individual minerals grew through the agency of solutions. The process is of wide extent and is available as an accessory in forming plutonic rocks.

Contributions to the Petrology of Japan, Philippine Islands and the Dutch Indies: J. P. IDDINGS and E. W. MORLEY.

Volcanic rocks have been collected from thirteen active volcanoes and from other localities in Japan, and chemical analyses have been made of sixteen of them. The igneous rocks of Luzon, P. I., were collected and studied, and six analyses made. They bear strong resemblances to rocks of Japan. In the Dutch Indies the leucitic rocks of Java, Bawéan and Celebes were collected, together with the associated lavas and intrusive rocks. Of these twenty-nine have been analyzed, besides seven from Timor and Sumatra. The leucitic rocks of Celebes were found to be much more extensive than heretofore supposed.

SYMPOSIUM ON THE EXPLORATION OF THE PACIFIC

(Continued from the Morning Session)

The Extent of Knowledge of the Oceanography of the Pacific: G. W. LITTLEHALES.

The accumulated oceanographical observations in the Pacific relate principally to the surface and the bottom. The intermediate depths have been little investigated. The materials from centuries of voyaging and from the expeditions for sounding the ocean sent forth since the last quarter of the nineteenth century, when deep-sea soundings first began to be taken in the Pacific, have provided information of the distribution of barometric pressure and winds over this vast tract and also of the general aspects of surface circulation, temperature and salinity. The manuscript sheets of the United States Bathymetrical Chart, containing all the authentic deep-sea soundings, are offered in evidence to show the extent to which the basin has been sounded and the distribution of bottom deposits made known, and to prove the inadequacy of existing measurements to define the contours of configuration beyond the continental shoulder. In the North Pacific there is a tract twice as large as the United States which has been crossed by only a single line of soundings at intervals about 250 miles wide apart; and a number of instances exist in which tracts as large as the United States remain entirely unfathomed. The deposits on the floor of the ocean have generally been penetrated only to the depth of a few inches, and little is known of their thickness or stratification. Of the variations, from

season to season and from year to year, of the temperature, salinity and gas-content in the depths of the Pacific, no observations have been made—not even in the lesser depths throughout which extends the interchange of heat between the ocean and the atmosphere; and consequently there is no knowledge of the import of such changes upon the variations of climate and of physical and biological oceanography. The observational foundation for investigating the ocean from the standpoint of thermodynamics does not exist.

Marine Meteorology and the General Circulation of the Atmosphere: C. F. MARVIN.

The proposal to organize a marine exploration of the Pacific ocean for making carefully planned scientific observations in oceanography, gravity, atmospherics and related subjects claims the great interest of the Weather Bureau and affords an opportunity to utilize the meteorological data now in the archives of that institution and hereafter to be collected by it in the discussion of observations to be collected during the expedition. Reports are now received by the Weather Bureau from 175 vessels traversing the main routes mostly of the Pacific oceans. Weather maps of the oceans can be constructed on some occasions at least, and in any case it may fairly be said that the proposed exploration must of necessity contemplate supplementing the meteorological data it collects by the more or less simultaneous information of related nature collected from every other vessel then at other points over the adjacent oceans. The greatest need in atmospherics of the present time is free air data. To secure these in fullest measure will require, at times at least, two points of observation one or two miles apart, for the purpose of triangulation as it were, and the expedition should be planned to provide for such a possibility as well as that of following free balloons by the aid of a small high-speed launch or sister ship of appropriate character. The meteorological observations that might form the working program of the expedition will be indicated and the personnel suggested. The paper will refer to or briefly summarize the data obtained from aerological work in the United States and draw inferences therefrom as bearing upon accepted theories of the general circulation of the atmosphere.

On the Distribution of Pacific Invertebrates: WM. H. DALL.

Mr. Dall will point out the importance of the distribution of marine invertebrates, as one of the keys to the former distribution of land masses, and to our very imperfect knowledge of their distribution in the Pacific. Certain species, usually those inhabiting the reefs and comparatively shallow water, are very widely distributed over the region usually referred to as Indo-Pacific; but when a careful collection of the species belonging to any isolated island or group is available it becomes evident that a large proportion of them are local and combine to form a local fauna. A knowledge of these faunas is necessary before any satisfactory discussion can be had of the presumably Tertiary fossiliferous deposits which are found fringing the more elevated Pacific islands. The land shells of the Hawaiian and Tahitian groups indicate a high antiquity for their isolation according to Pilsbry, the most eminent student of these animals. The facies of the Tertiary fossils obtained by Ochsner on the Galapagos Islands indicates a derivation from the American rather than the Indo-Pacific fauna, with which the recent invertebrates are commingled. These facts indicate the interest which attaches to a wider knowledge of the Pacific faunas.

Land Mollusca of the Pacific: H. A. PILSBRY.

Present knowledge of Pacific land snail faunas is fairly adequate only for the Hawaiian and Society groups, but fragmentary data are available for many other islands. Some distinctively continental families extend as far out as Fiji, the western Carolines and the Bonin Islands. Beyond this there is another fauna, its striking feature being the absence of all highly evolved continental groups. This Pacific fauna consists partly of groups known by paleontological evidence to be old (such as the Succineidæ and Endodonts), and partly of a series of families having a primitive organization resembling aquatic air-breathing snails; *Achatinella* and *Partula* being the best known representatives. These hold a relation to the higher land snails analogous to that of the monotremes to placental mammals. Their adaptive modifications often parallel those of fundamentally diverse continental snails. The hypothesis that Pacific snails reached the islands by oversea drift leaves the absence of higher snails unexplained. The distribution of the faunas and their antique aspect suggest that there were large antecedent land masses, upon which the present relatively modern volcanic islands were superposed during subsidence.

Marine Algæ of the Pacific Islands: W. G. FARLOW.

In any future expedition to the Pacific Islands

the plankton species should, of course, be collected wherever and whenever possible. In our present fragmentary knowledge of the littoral and sublittoral flora of the Pacific, it is not possible to say just what are likely to be the most important general problems ultimately to be investigated. What is first needed is a more detailed knowledge of the flora of certain centers than we at present possess. A practical question is what regions can be better explored by a special expedition and what regions can be sufficiently well studied by resident algologists. In the latter category should be included the islands on the western limit as the Bonin and Loochoo Islands and Formosa, now studied by the Japanese and the outlying Sandwich Islands where large collections have recently been made by some of our own algologists. The flora of the Philippines, although not well known, can be studied from collections easily made by local botanists. From the islands in Polynesia proper, as the Fiji and Samoa Islands which lie on the route from Australia to North America we have a certain amount of material which has been studied by experts, as Harvey and Grunow, but of the islands to the east of the Friendly Islands we have, with the exception of Tahiti, almost no knowledge. It therefore seems to be advisable that an exploring expedition should make the Fiji Islands or Samoa a center from which to explore the islands to the eastward as far as the Marquesas Islands. If means permit, starting from the same base, it would then be desirable to visit the islands extending as far to the northwest as the Caroline and Ladrone Islands, of whose flora we have a partial knowledge from collections made by some of the exploring expeditions of the last century.

Problems of the Pacific Floras: D. H. CAMPBELL.

The Pacific as a Field for Anthropological Investigation: J. W. FEWKES.

There is no large island in the Pacific ocean which was uninhabited by man when discovered by Europeans, and several show evidences of human occupation for a considerable antiquity. Our knowledge of the Polynesians is very deficient. This race presents many anthropological problems of great interest. From what direction, how and when did man migrate across the Pacific from one isolated island to another; how many traits of ancestral culture still remain, and how much have they been modified by oceanic insular environment, are questions which await intensive work in this field before they can be satisfactorily answered. Where there are so many unsolved problems, it is almost impossible to single out one in preference to others; but perhaps that which appeals most directly to us is the part the Pacific may have played in the aboriginal peopling of America. We know next to nothing of the physical features, much less of the language and comparatively little of the material culture of this race. Our knowledge of the history of the inhabitants of the Pacific islands is small. There are archeological remains scattered from Java to Easter Island. Our knowledge of the physical anthropology, linguistics and ethnology of Australia is very limited. Much that has been published ought to be critically examined and amplified by intensive studies. Anthropological work in the Pacific will be a service to science by shedding a flood of light on culture history. The harvest is sure to be great if we can find the man competent to gather it.

PAPERS OF THE REGULAR PROGRAM

Hereditary Transmission of Defects resulting from Alcoholism. (By invitation of the Program Committee.) CHARLES R. STOCKARD.

Recent Observations on the Activity of some Glands of Internal Secretion: W. B. CANNON.

Studies on conditions of activity of the adrenal glands have shown that during emotional excitement they secrete into the blood a substance which affects the bodily organs in a manner simulating the nervous influences of strong emotions. Electrical studies of the thyroid gland indicate that it also is brought into action in great emotional excitement, both by nervous and by chemical stimuli. These glands have a routine function without which certain bodily processes are not normal. They may also be reasonably regarded as having emergency functions which are called forth in times of emotional stress and are important for the needs of the organism (*e. g.*, for struggle) under such circumstances.

Studies in the Water Content of the Nervous System: H. H. DONALDSON.

8:00 P.M.—Auditorium, National Museum.

First William Ellery Hale Lecture, by Henry Fairfield Osborn, president of the American Museum of Natural History. Subject: "The Origin and Evolution of Life on the Earth." (Illustrated.)

The lecture will be followed by a conversazione in the art gallery of the museum. All members of the scientific societies of Washington, with ladies,

are cordially invited to attend both lecture and conversazione. No cards are necessary.

TUESDAY, APRIL 18

Morning Session

10:30–12:45 A.M.—Auditorium, National Museum. Public scientific session for the reading of papers.

Some Recent Results of Solar Research: GEORGE E. HALE.

The new results include photographs and stereograms of the solar atmosphere made with a 13-foot spectroheliograph; part of a new map of the sun-spot spectrum, on a scale of one centimeter to the angstrom, showing the magnetic phenomena of sun-spots; illustrations of the Stark effect for hydrogen and lithium; and observations indicating that the northern and southern sun-spots of the present cycle, irrespective of latitude, are opposite in magnetic polarity to the corresponding spots of the preceding cycle, while the chromospheric vortices associated with spots did not undergo a similar reversal in sign at the minimum.

An Investigation of the Suggested Mutual Repulsion of Fraunhofer Lines: CHARLES E. ST. JOHN (introduced by G. E. HALE).

Those who assign an important rôle to anomalous dispersion in the solar atmosphere deduce from the theory a mutual influence between the components of close pairs of Fraunhofer lines, which operates to increase their distance apart. Investigations now nearing completion show that the relative positions of lines in close solar pairs conform to their relative positions in terrestrial spectra to the same degree of precision as free-standing solar lines which are not under the influence of neighboring lines, and the violet and red components are not displaced to the violet and red respectively as the theory demands that they should be in the solar spectrum.

Anomalous Dispersion Phenomena in Electric Furnace Spectra: ARTHUR S. KING (introduced by G. E. HALE).

Strong anomalous dispersion effects have been produced by passing white light through metallic vapors in an electric furnace. A study under high dispersion of spectrum lines very close together gave no indication of the mutual repulsion predicted by Julius when one of the lines in question shows high anomalous dispersion. Other experiments, in which the wave-length of a line was measured when alone and also when very close to a strong line of another element, gave no difference greater than 0.001 angstrom.

Illustrations of the New Spectroscopic Method of Measuring Stellar Distances: WALTER S. ADAMS (introduced by G. E. HALE).

The method of determining the actual light emission of a star from the appearance of the absorption lines in its spectrum has proved a valuable way of measuring stellar distance, since the difference between the actual and apparent brightness of a star depends only on its position in space. The new method has been used to determine the distance of a remarkable pair of faint stars in the southern sky, showing that the components move in parallel paths at the greatest known stellar velocity—about 600 km. a second. Another interesting application relates to the total light emission of the sun. By simply comparing the relative intensities of five lines in the solar spectrum the apparent brightness can be estimated with an accuracy comparable with that of direct photometric measurement.

Some Results with the New 10-inch Photographic Telescope: HARLOW SHAPLEY (introduced by G. E. HALE).

The new Cooke photographic triplet of 10 inches aperture, focal length 45 inches, has been used with a 15-degree objective prism to photograph spectra of faint stars. The scale is three minutes of arc to the millimeter and a single plate covers nearly 400 square degrees. As many as 10,000 spectra have been photographed at one exposure. The instrument has been applied to the study of Cepheid variables, and the spectra of about a dozen have been found to vary periodically with the light.

The Pyranometer, an Instrument for the Measurement of Sky Radiation: C. G. ABBOT AND L. B. ALDRICH.

The authors have perfected an instrument to measure the radiation originally forming a part of the beam of rays from the sun, but which reaches the observer by scattering from all parts of the sky. The instrument can also measure the radiation outward toward the sky and space at night, comprising those long wave-length radiations which are purposely excluded in the daylight measurements. For the first purpose the instrument is provided with an optically figured hemispherical shell of ultra-violet crown glass about 2 mm. thick. The diameter of the shell is about 25 mm. For nocturnal radiation measurements this shell is not employed. The horizontal measuring surface is a thin blackened strip of manganin about

6 mm. long, 3 mm. wide, and 3/1,000 mm. thick, placed centrally and level with the surface of a circular nickel-plated copper plate 12 mm. thick, 75 mm. in diameter. The manganin strip is electrically insulated from the copper plate by means of thin strips of mica which come exactly to the common surface of the plate and strip. Underneath the manganin strip are cemented two thermo-elements of tellurium and platinum joined in series, and whose cool junctions are embedded in opposite halves of the copper plate. A polished nickeled hemispherical shutter encloses the outside of the glass hemisphere, and when it is open the radiation from the sky passes through the hemisphere, falls upon and is absorbed by the upper surface of the manganin strip. Thus the thermo-elements are warmed and deflection of the galvanometer connected with the apparatus would ensue. But this is reduced to zero by means of an auxiliary current supplied by a potentiometer arrangement. Having secured the balance by means of the potentiometer circuit, the shutter is now closed and a heating current is applied to the manganin strip until the temperature is again raised so that with the same potentiometer current the galvanometer again stands at zero. In these circumstances, as in the Ångström pyrheliometer, the energy of the current expended in heating the strip is equal approximately to the energy of the sky radiation which heated the strip before. This apparatus has been used with excellent results on the snow, the sky, the sky and the sun, and the sun alone. In the latter case the instrument was compared with a standardized silver-disk pyrheliometer. Corrections having been made for the inclination of the rays to the surface of the horizontal sky radiation instrument, reflection of glass, and imperfect absorption of the lamp-black close agreement was found between the results derived from the two kinds of apparatus. We are of the opinion that with this apparatus the sky radiation can be measured to within perhaps 2 per cent. The reflecting power of snow for total solar radiation was found to be 70 per cent. In using the apparatus for the measurement of nocturnal radiation the glass hemisphere is removed. Upon the opening of the shutter the strip cools and thereby a deflection is produced in the attached galvanometer. This deflection, however, is brought to zero by introducing in the strip a heating current such that the temperature is restored to what it was before the shutter was removed. It is plain that the instrument may also be used for the measurement of the radiation of inclosures at fixed known temperatures which might be regarded as perfect radiators. We hope to make experiments of this kind in the effort to aid in the determination of the constant of Stefan's fourth power formula for the radiation of black bodies.

Invisible Companions of Binary Stars: G. C. COMSTOCK.

A large proportion of the visible stars are shown spectroscopically to be accompanied by companions not separately visible. In a very limited number of cases, such companions have been otherwise found. The presence of such invisible companions is possibly, or even probably, a normal stellar attribute. Aside from spectroscopic investigation, and in a field not accessible to it, the most promising method of search for such bodies is to be found in the disturbances produced by them in the motions of binary systems. This has been realized in a very few cases, *e. g.*, Zeta Cancri. The present paper suggests a simple method of testing suspected cases of this kind and shows by its application to Zeta Herculis that this star is probably a triple system in which the relative masses are of the order 100: 10: 1. The two smaller bodies are separated by only a twentieth of a second of arc.

Theory of Electric Conduction in Metals: EDWIN H. HALL.

In July, 1914, the author published[1] a paper in which he reached the conclusion that the so-called free electrons have little to do with electric conduction in metals but have an important function in thermo-electric action. In 1915 he made the suggestion[2] that the metal ions,—which are probably equal in numbers to the free electrons in a metal—may be of great effect in electric conduction. The idea is that during a collision between an atom and an ion an electron may be transferred from the atom to the ion by the action of a potential gradient due to an externally applied E.M.F., whereas in the collision of two atoms the electron would not pass. It can be shown that a comparatively small number of ions might serve to maintain a very powerful current. Some progress has been made in adapting this general theory to the requirements of Ohm's law and the known temperature relations of electric conduction in metals.

[1] *Proceedings of the American Academy of Arts and Sciences.*

[2] In *Il Nuovo Cimento*, the first number for 1915.

The Evolution of the Stars: F. R. Moulton.

The Minor Planets discovered by James C. Watson: A. O. Leuschner, Watson Medallist.

Afternoon Session

2:30–6:00 P.M.—Auditorium, National Museum.

Biography of Professor Theodore Nicholas Gill: Wm. H. Dall. (By title.)

Biography of Professor Edward Singleton Holden: W. W. Campbell. (By title.)

Biography of Professor Simon Newcomb: W. W. Campbell. (By title.)

Report of the Work of the Committee upon the Panama Canal Slides: Charles R. Van Hise, Chairman.

The Mechanics of the Panama Slides: H. Fielding Reid.

The Present State of Knowledge of the Extreme Ultra-Violet: Theodore Lyman, Director Jefferson Physical Laboratory, Harvard University. (By invitation of the Program Committee.)

The paper aims to present a résumé of the results which have been obtained in the region of very short wave-lengths since the researches of Schumann came to an end. The limit of the spectrum and the means which may be used to extend it, form the dominating feature of the article.

A Redetermination of e and N: Robert A. Millikan.

In view of the far reaching significance of the electronic charge and the apparent adaptability of the "droplet method" to its very exact determination, an effort has been made during the past year to push this method to the limit of its possible precision. Droplets made from different substances and falling in different gases have been used. All the constant factors involved in the experiment have been redetermined. Details of the measurements will be published elsewhere. The final result is in exceedingly close agreement with the value obtained by the author and published in 1913, namely $e = 4.774 \times 10^{-10}$ electrostatic units.

The Relation of Investigational Work to the Enforcement of the Food and Drugs Act: Carl L. Alsberg, Chief of the Bureau of Chemistry, United States Department of Agriculture. (By invitation of the Program Committee.)

Recent Exploration on the Mesa Verde National Park, Colorado: J. Walter Fewkes.

Wherever we turn in certain sections of our southwest, we find mounds, ruins and evidences of prehistoric buildings. Their very multiplicity tends to confuse the mind, especially when it attempts to interpret their significance in culture history. The first step in anthropology, as in other natural sciences, is classificatory: Prehistoric culture is largely determined by architecture and ceramics. We need a reliable classification of these data. Manifestly linguistics or even physical anthropology are not adequate to give a satisfactory picture of the culture history of the people who inhabited a large part of our southwest. We must look to archeological data, especially architecture, for a knowledge of an unlettered prehistoric people. The object of the present communication is to record the progress of archeological work in the Mesa Verde National Park for the purpose of enlarging our knowledge of the prehistoric culture of southwestern Colorado. Incidentally it is an endeavor to show what the author regards as the scientific method of excavating southwestern ruins and of preparing and preserving them for future students. It has special reference to the field work in the summer of 1915 and is a continuation of work already accomplished in the years 1908, and 1909, when two large ruins—Spruce-tree House and Cliff Palace—were excavated and repaired to serve as type ruins of cliff dwellers. The plan of the field work in 1915 was the excavation of a mound on the point of the mesa opposite Cliff Palace. It was believed that a ruin belonging to a type unlike cliff dwellings was covered by this mound. The work was successful, and not only a new type of building was exposed, but the features brought to light indicate that it was constructed for rites connected with worship, in which the sun plays a prominent rôle. The method of excavation, repair and preservation of Sun Temple, as well as unique features developed, will be illustrated by lantern slides.

Further Evidence on the Nature of Crown Gall and Cancer and that Cancer in Plants Offers Strong Presumptive Evidence both of the Parasitic Origin and of the Essential Unity of the Various Forms of Cancer in Man and Animals: Erwin F. Smith.

WEDNESDAY, APRIL 19

1:00 P.M.—Auditorium, National Museum.

Second William Ellery Hale Lecture, by Henry Fairfield Osborn, President of the American Museum of Natural History. Subject "The Origin and Evolution of Life on the Earth." (Illustrated.)

SCIENCE

FRIDAY, APRIL 21, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PRESENT STATE OF THE PROBLEM OF EVOLUTION[1]

THE exchange of professors between the Sorbonne and Harvard University for the first time brings to Cambridge a professor of science. In a certain way I come in return for the visits which Professor M. Bôcher and Professor W. M. Davis have already made to the faculty of sciences at Paris. All my predecessors belonged to our faculty of letters. All have brought back a recollection of the hearty welcome which they received, and what they told me contributed largely in inducing me to accept the mission which was offered to me. I had the assurance of good-will and generous sympathy from my colleagues as well as from my pupils.

In the beginning I must excuse myself for not being able to express myself, at least for the present, in English. The most important point in teaching is clearness in expressing thoughts. By speaking to you in my own language I hope to succeed much better in a difficult subject and for that reason to obtain forgiveness for the effort which, to my great regret, I occasion you.

The purpose of the exchange between the two universities is to convey to the one the methods of teaching employed in the other. I have the honor to occupy at the University of Paris a chair of biology especially devoted to the study of the evolution of organic beings. It is then to the present state of this great problem that the lectures

[1] An introductory lecture in a course offered by M. M. Caullery as exchange professor at Harvard University, February 24, 1916. Translated from the French by Mrs. C. H. Grandgent.

which I am going to give will be dedicated. I do not enter upon this subject here without some apprehension. Certain of my predecessors, by the very nature of their subjects, were able to have, at least the illusion, that Europe is still the veritable center of learning. But I have not this advantage. The necessary conditions for the development of the sciences are now at least as well fulfilled, I will even say better fulfilled, in the United States than in Europe, and for many of the sciences, Europeans coming to this country have as much to learn as to teach. This seems to me particularly the case in biology and especially in the questions connected with the problem of evolution.

Besides, the advance of American science in these directions does not date from yesterday. In the study of paleontology, which has a large place in the questions with which we are to concern ourselves, your scholars have, for a long time, been working with activity and considerable success the marvellous layers of American deposits, and have drawn from them, to cite only one instance, magnificent collections of reptiles and mammals, which we come to admire in the museums on this side of the Atlantic. Here more than anywhere else have been enlarged the paths opened a century ago by George Cuvier. In zoology, properly speaking, the museum of comparative zoology, in which I have the honor to speak at this time, justly famous in Europe, bears witness to the importance and long standing of the results accomplished. Louis Agassiz, more than half a century ago, was one of the most eminent names of his generation. Later, when the investigation of the great depths of the ocean marked an important and consequent stage in the knowledge of earth and life, Alexander Agassiz, his son and illustrious successor, was one of the most eager and skillful workers. The expeditions of the *Blake* and of the *Albatross* are among those which have drawn from the deep the most important and most precious materials, and their results have been the most thoroughly studied. The personality of Alexander Agassiz, whom I had the honor of meeting in Paris about thirteen years ago, made upon me a striking impression. His real laboratory was the ocean, and he succeeded to the end of his life in maintaining an activity that corresponded to its amplitude. He was truly the naturalist of one of the great sides of nature. Around Louis and Alexander Agassiz, the museum and the laboratory of comparative zoology of Harvard College have been for a long time a center of studies of the first rank. In the domain of embryology Charles S. Minot also has carried on important work. But it is especially at the present moment that American biological science has made an amazing advance which expresses itself in the excellence of publications and in the results which they reveal by the number of collaborators, the activity of societies, the number of laboratories, and the abundance of material resources at their disposal. Here occurs a special factor, which has considerable importance, the enlightened and large generosity of numerous patrons. It is incontestable that men of talent find more easily in America than in Europe, and especially at the age of their full activity, the cooperation without which their greatest efforts are to a certain extent barren. Now, at the point to which we have arrived, the greater part of scientific problems demands the exercise of considerable pecuniary resources and of collaborators of various capabilities. This is particularly true of biology, where, moreover, many questions, notwithstanding their scientific importance, do not lead to practical application, at any rate immediately. We succeed too rarely in

Europe in combining these resources, above all in combining them rapidly enough. The European public does not sufficiently realize their necessity and interest. And the action of the state necessarily lacks the flexibility needful for rapid realization. Thus Pasteur was able to organize the institution which bears his name only at the end of his life, and at the inauguration he was heard to say mournfully, "I enter here defeated by Time." In America the power and the eagerness which private initiative gives provide for this need. Truly the greatest wonder is that this liberality is generally well conceived and well employed.

It is also true that the problems of the day in contemporaneous biology are nowhere else attacked at the present time with such activity, perseverance, and success as in the United States. As we look at different points on the biological horizon, we see the studies on the Mendelian theory of heredity in full development in numbers of laboratories. It will be enough for me to cite in this connection the names of Messrs. Castle and East in this very spot, and that of Mr. T. H. Morgan in New York. In the realm of the physiology and the structure of the cell and of the egg, the researches of E. B. Wilson, and of his pupils on the chromosomes, of J. Loeb on experimental parthenogenesis, of F. R. Lillie on the fertilization of the egg, of Calkins and recently of Woodruff on the senescence of the infusoria, suffice to show the share which this country has had in the advance of knowledge. And I ought also to mention numerous works on embryology and on the study of the filiation of the cells of the embryo (cell-lineage), on regeneration, on the behavior of the lower organisms, on geographic distribution and the variations of the species studied from the most diverse sides; all branches of biology are flourishing vigorously. In addition, the United States, more than any other country, has developed scientific institutions designed for the study of the application of biology to agriculture, to fisheries, etc.

In the face of this situation, I wish to make it clear at the outset that I have not the least expectation of bringing here a solution of the problem of evolution. I have too full a realization of the extent of the scientific movement aroused by this question in the United States and I hope to derive great benefit myself from my stay here, from the contact which is permitted me with my colleagues and with their laboratories. This latter advantage is not the least which arises from the exchange between the two universities. Nor have I the expectation of bringing to you a new solution of the problem, nor of examining it from a special and original point of view, such as might be the case in a single lecture or a small number of lectures.

I will adhere strictly to the point of view of the instructor, taking the question as a whole, expounding it in its older aspects as well as in its more recent ones. The interest in these lectures is above all, in my opinion, in the coordination of facts and in their critical examination. As this coordination is influenced in a large measure by the surrounding conditions, the view that a naturalist has of them in Paris ought to be interesting here. In questions as complicated and as undeveloped as these still are, where we have not reached a precise conclusion, the relations of facts can not be established in a harsh and unequivocal fashion. This is particularly true of the problem of evolution at the point we have reached. During the last few years very rapid and great progress has been made in our knowledge relative to certain kinds of data; notably heredity and variation. But they have not failed to shake markedly the notions which previously seemed to be

at the very foundation of evolution. One of my compatriots, an ardent disciple of Lamarck, F. Le Dantec, wrote even as far back as eight years ago a book bearing the significant title "La Crise du Transformisme"[2] in which he brought out the contradictions in question, contradictions which, according to him, were to result in the ruin of the very idea of transformism. Since that time opposition has become even more marked and at the present day, either tacitly or explicitly, certain of the most authoritative men, by their works, have arrived very near to a conception which would be the negation of transformism rather than its affirmation.

The term "evolution," in French at least, has had historically two contrary meanings. In the eighteenth century, it was the expression of the theory of the preformation or "emboitement" of the germs, according to which the lot of every organism was determined from the beginning. The succession of generations was only the unfolding (*evolutio*) of parts that existed from the beginning. In the nineteenth century, and it is in this sense that it is always used now, it had an opposite sense; it is the synonym of transformism and it signifies the *successive* transformation of animal or vegetable organic types, not realized beforehand, in the course of the history of the earth, under the influence of external causes. Now, if one admits the general value of certain of the ideas recently expressed, evolution would be only the unfolding of a series of phases completely determined in the germs of primitive organisms. It is a reversion, under a modern form, to the idea which the word evolution represented in the eighteenth century. It is unnecessary to say that I use the word evolution in its nineteenth-century sense, which is synonymous with transformism. It is evident then that all is far from being clear in the present conception of transformism and that, in consequence, an exposition of its various aspects and an effort to coordinate them is not a useless thing in a course of lectures. Furthermore a comprehensive glance at the principal questions which we shall have to examine will make my meaning clear and will give me the chance to indicate the general plan of the course.

In spite of the contradictions to which I have just alluded, the reality of transformism as an accomplished fact is no longer seriously questioned. We can make the statement that, in the unanimous opinion of biologists, evolution, that is to say, the gradual differentiation of organisms from common ancestral forms, is the only rational and scientific explanation of the diversity of fossil and living beings. All the known facts come easily under this hypothesis. All morphology in its different aspects, comparative anatomy, embryology, paleontology, verifies it. By virtue of this same hypothesis, these different branches of morphology have made an enormous progress since Darwin's day. The significance of certain categories of facts, especially in the domain of embryology, may have been exaggerated. Scientific men have certainly overworked the idea that the development of the individual, or ontogeny, was an abridged repetition of phylogeny, that is to say, of the several states through which the species had passed, an idea which Haeckel raised to the fundamental law of biogenesis and which a whole generation of naturalists accepted almost as a dogma. Without doubt, ontogeny, in certain cases, shows incontestable traces of previous states, and for that reason embryology furnishes us with palpable proofs of evolution and with valuable information concerning the affinities of groups. But there can no

[2] "Nouvelle collection scientifique," Paris, Alcan.

longer be any question of systematically regarding individual development as a repetition of the history of the stock. This conclusion results from the very progress made under the inspiration received from this imaginary law, the law of biogenesis.

The first part of the course will be devoted then to the consideration of the general data which morphology furnishes toward the support of the idea of evolution. Thus we shall see what conception comparative anatomy, embryology and paleontology affords us of the way in which evolution is brought about, and within what limits we may hope to reconstruct it. Evolution is essentially a process which belongs to the past and even to a past extraordinarily distant. It is a reasonable supposition that evolution is going on to-day, but let us remember that nothing authorizes us to believe that what we may observe in the present epoch about organisms will necessarily explain the succession of their former states. Evolution is an irreversible process and one which has not progressed at a uniform rate. We must not then expect to verify necessarily by the present organisms all the facts disclosed by morphology. It follows in my opinion that morphological data may force upon us indirectly certain conclusions even though we should have no experimental proof of them in contemporary nature.

Because of this very limitation which I have just pointed out, much of the difficulty of the study of the mechanism of evolution arises and to this may be attributed many of the profound differences among naturalists on the subject of evolutionary mechanism. The second part of the course will be devoted to the examination and the criticism of the solutions that have been proposed.

In a general way, the study of the mechanism of evolution is that of the reciprocal influence of agents external to the organisms, on the one hand, and of the living substance, properly speaking, on the other hand. There are then, if you wish, the external factors which together constitute the environment, and the internal factors which are the specific properties of the organism. These two elements are very unequally accessible to us. The environment is susceptible of being analyzed with precision, at least as far as the present is concerned, and we can surmise it with enough probability as to preceding periods. We know very much less about living matter, and especially about the way in which its properties may have varied in the course of time. Hence one meets with two tendencies which have been encountered ever since the evolutionary question arose and which are still very definite and very contradictory in their effects on the general theories of evolution. One of those attributes a large share to the external factors and attempts to explain facts by physicochemical actions which are directly accessible. The other sees in internal factors, in the intrinsic properties of the organism itself, preponderant if not exclusive agents.

The first tendency attracts us more because it gives a larger share to analysis, that is to say to the truly scientific method. The second flatters our ignorance with fallacious verbal explanations. It is open to the objections brought against vitalist conceptions; and when, as is the case of certain old and new theories, we come to restrict the effective rôle to internal factors alone, we may ask ourselves whether there is a really essential difference between conceptions of this nature and creationist ideas; between declaring that species have been created successively and arbitrarily by an arbitrary sovereign will, without the external world having influenced their structure, or maintaining that organic forms

succeed one another, derived to be sure one from another, but following a succession that is really determined in advance and independent of external contingencies. Between such views there is in reality no considerable difference. Such an idea substitutes for successive creations one initial creation with successive and continuing manifestations. The present crisis of transformism, as Le Dantec and others set it forth, is the conflict concerning the reciprocal value of external and internal factors in evolution.

The two principal and classic solutions proposed to explain evolution were based on the efficacy of external factors, both the theory advanced by Lamarck in 1809 in his "Philosophie Zoologique," as well as that of Darwin formulated in 1859 in "The Origin of Species." Lamarck starts in fact with the statement that the structure of organisms is in harmony with the conditions under which they live and that it is adapted to these conditions. This adaptation is, in his opinion, not an *a priori* fact but a result. The organism is shaped by the environment; usage develops the organs in the individual; without usage they become atrophied. The modifications thus acquired are transmitted to posterity. Adaptation of individuals, inheritance of acquired characteristics, these are the fundamental principles of Lamarckism. Except for its verification, it is the most complete scientific theory of transformism which has been formulated, because it looks to the very cause of the change of organisms by its method of explaining adaptation. Darwin adopted the idea of Lamarck and admitted theoretically adaptation and the inheritance of acquired characteristics, but he accorded to them only a secondary importance in the accomplishment of evolution. The basis for him is the variability of organisms, a general characteristic whose mechanism he did not try to determine and which he accepts as a fact. This being so, the essential factor of the gradual transformation of species is the struggle for life between the individuals within each species and between the different species. The individuals which present advantageous variations under the conditions in which they live have more chance to survive and to reproduce themselves; those which on the contrary offer disadvantageous variations run more chance of being suppressed without reproducing themselves. There is established then automatically a choice between individuals, or, according to the accepted terminology, a *natural selection*, a choice which perpetuates the advantageous variations and eliminates the others. And with this going on in each generation the type is transformed little by little. Natural selection accumulates the results of variation.

This is not the time to discuss Darwin's theory. I wish only to observe to-day that it is less complete than that of Lamarck in that it does not try to discover the cause of variations; also that, like that of Lamarck, it attributes a considerable participation to the conditions outside the organism, since it is these finally which decide the fate of the variations. And one of the forms in which the opposition to the transformist ideas, at the time of Darwin, manifested itself, was the very argument that if organisms had varied it was only because of an internal principle, as Kölliker and Nägeli have more particularly explained.

The biologists at the end of the nineteenth century were divided with regard to the mechanism of evolution, into two principal groups, following either Lamarck or Darwin. Among the neo-lamarckians some have accorded to natural selection the value of a secondary factor, holding that the primary factors are the direct

modifying influences of the surroundings which according to them cause the variations. Selection came in only secondarily, by sorting out these variations and especially by eliminating some of them. Such was the particular doctrine developed by my master, A. Giard, at the Sorbonne. Others have more or less absolutely refused to grant any value to selection. Such was the case of the philosopher Herbert Spencer. We must also recognize that, since the time of Darwin, natural selection has remained a purely speculative idea and that no one has been able to show its efficacy in concrete indisputable examples.

The neo-darwinists, on their side, have, in a general way, gone further than Darwin because they see in selection the exclusive factor of evolution and deny all value to Lamarckian factors. This was the doctrine of Wallace, and has been especially that of Weismann. I will digress a moment to speak of the ideas of these last-mentioned authors, because of the influence which they have exerted and still exert, correctly in some respects, incorrectly in others, at least as I think.

Weismann attacked the doctrine of the inheritance of acquired characteristics and has incontestably shown the weakness of the facts which had been cited before his time in support of this kind of heredity. But he went too far when he tried to show the impossibility of this form of heredity. In so doing, he starts from a conception which meets with great favor; the radical distinction between the cells of the body proper, or *soma*, and of the reproductive elements or germ cells. He saw, in these two categories, distinct and independent entities, the one opposed to the other. *Soma* which constitutes the individual, properly speaking, is only the temporary and perishable envelope of the *germ* which is itself a cellular autonomous immortal line, which is continuous through successive generations, and forms the substratum of hereditary properties. The germ alone has some kind of absolute value. The *soma* is only an epiphenomenon, to use the language of philosophers. The *soma* is of course modified by external conditions, but for one to speak of the inheritance of acquired characteristics, the local modifications of the *soma* would have to be registered in the germ and reproduced in the same form in the *soma* of following generations, in the absence of the external cause which produced them in the first place. Now, says Weismann, the possibility of such an inscription, as it were, upon the germ of a modification undergone by the *soma* is not evident *a priori*, and when we go over the facts we find none supporting this conclusion. There are indeed modifications which appear in one generation and which are reproduced in the following generations; but Weismann goes on to attempt to prove that at their first appearance they were not the effect of external factors on the *soma*, but that they proceeded from the very constitution of the germ, that they were not really acquired and somatic, but were truly innate or germinal.

Such reduced to its essential points is the negative contention of the doctrine of Weismann. It rests upon the *absolute* and abstract distinction between the *soma* and the *germ*. In spite of the support which this conception has had and still has, I consider it, for my part, as unjustifiable in the degree of strictness which Weismann has attributed to it. It is true that the advance in embryology and cytology often allows us to identify the reproductive tissue and to follow it almost continuously through successive generations, but the conception of its autonomy is at least a physiological paradox. Though the continuity of the germ cells is sufficiently evident in many

organisms, it is more than doubtful in others, particularly in all those which reproduce asexually, that is to say, many large groups of animals like the Cœlenterata, the Bryozoa, the Tunicata, and many plants. This has more than the force of an exception, it is a general principle of the life of species. One can not then say that the conception of Weismann carries full conviction. But this conception exercised a tyrannical influence upon the minds of contemporaneous biologists and it is exclusively through it that most of them look at the facts.

Weismann, besides, exercised a considerable influence by championing a theory of heredity based at the start on the preceding ideas. This theory, built with undoubted ingenuity, and adapted to the knowledge gained from the study of cell division, turns out on the other hand to agree with the recent works on heredity.

Lamarckism and Darwinism shared the support of biologists up to the end of the nineteenth century, discussion being in general restricted to speculation. The controversy begun in 1891 between Weismann and Spencer, who represented the two extremes, gives an idea of the extent to which one could go in this direction.

The last twenty years constitute indisputably a new period in the history of transformism where the field of discussion has been renewed and scientists have sought to give it a much more positive and experimental character. Two kinds of investigation have been developed in this direction: on one hand the methodical study of variations, and on the other that of heredity and especially of hybridization. These two categories overlap.

Note that this new point of view is not, properly speaking, a study of evolution. According to it, variation and heredity in themselves, under present conditions, are analyzed independently of all hypothetical previous states of the organism. Afterwards the results obtained with the Lamarckian, Darwinian and other succeeding theories will be confronted.

The sum of these researches, which are now in high favor, is a new and important branch of biology, which has received the name of *genetics*. It defines for us in particular the hitherto very vague notion of heredity and seems certain to lead us to an analysis of the properties of living substance somewhat comparable to that which the atomic theory has afforded concerning organic chemistry. We can not maintain too strongly its great importance. As far as the theory of evolution is concerned the results obtained up to this time have been rather disappointing. Taken together, the newly discovered facts have had a more or less destructive reverberation. In truth the results obtained do not agree with any of the general conceptions previously advanced and do not show us how evolution may have come about. They have a much greater tendency, if we look only to them, to suggest the idea of the absolute steadfastness of the species. We must evidently accept these facts such as they are. But what is their significance? On the one hand they are still limited, on the other hand as I have already indicated above, and as I shall try to show in the following lectures, the advances made by the study of heredity in organisms, at the present time and under the conditions in which we are placed, does not permit us to accept *ipso facto* the doctrine of heredity for all past time and under all circumstances.

To use a comparison which has only the force of a metaphor but which will make my thought clear, the biologist who studies heredity is very much like a mathematician who is studying a very complex function with the aid of partial differential equa-

tions and who tries to analyze the properties and the function about a point without being able as in the case of an elementary function to study it in itself, directly, in all its aspects. The properties ascertained about one point are not necessarily applicable to all space.

As far as the organisms are concerned, the conditions of their variability have not certainly been the same in all periods. The idea of a progressive diminution of their variability has been often expressed, notably by D. Rosa. Le Dantec, according to his favorite theoretical method in which he considers only the fundamental principles of the problem, has tried to reconcile these facts with the Lamarckian doctrine in his book on La Stabilité de la Vie.[3] In the transformation of organisms as well as in that of inert matter, he regards every change as the passage from a less stable to a more stable state. The many organisms, after having varied much and rapidly, might then, perhaps, be for the present in a state of very constant stability, at least the greater part of them. But for the time being, I must omit further consideration of this suggestion.

We shall have then in the third part of the course to examine, while bearing in mind the preceding opinions, the general results of recent researches in variation and heredity. I shall now sum up the principal lines of investigation preparatory to tracing the plan of these lectures.

The methodical study of variations in animals and in plants has led us to recognize that the greater part of these variations are not inherited. If we apply to them the methods of the Belgian statistician Quetelet, we shall perceive that for each property numerically stated the different individuals of a species range themselves according to the curve of the probability of error, the greatest number of individuals corresponding to a certain measure which represents what is called the mean. The term *fluctuation* is given to those variations that are on either side of the mean and the study of these fluctuations, begun in England by Galton, has been developed and systematized by H. de Vries and Johannsen.

In short, it is the whole of the curve of fluctuations which is characteristic of heredity in a given organism, and not such and such a particular measure corresponding to a point in the curve. In cross-bred organisms there is, in each generation, an intermixture of two very complex inheritances, since these organisms result from an infinite number of these intermixtures in former generations. On the contrary, the problem is very simplified, if one considers the organisms regularly reproducing themselves by self-fertilization as is the case in certain plants. Here there is no longer in each generation a combination of new lines, but a continuation of one and the same line. It is the same hereditary substance which perpetuates itself. The Danish physiologist and botanist Johannsen attacked, as you know, the problem in this way, by studying variation along a series of generations in lines of beans, and the conclusion of his researches, which have had in recent years a very great influence is *that each pure line gives a curve of special fluctuations under special conditions.* The variations that we observe in the action of external agents explain the different reactions of the hereditary substance to the conditions of the environment, but this substance itself remains unaltered. The consequence is that, in what since the time of Linné we have considered a species, and have admitted to be a more or less real entity, there is an infinity of lines, more or less different among themselves in their

[3] "Bibliothèque scientifique internationale," Paris, Alcan.

hereditary properties, which are fixed and independent of environment. This it is that Johannsen calls the *biotype,* or *genotype;* a species is nothing but the sum of an infinity of genotypes differing very little from one another. H. de Vries on his side reached analogous views which prove to harmonize with the results and ideas formulated some forty years ago by a French botanist, Jordan, an unyielding adversary of transformism. Jordan, too, by means of well-ordered cultures, had analyzed a species of crucifer (*Draba verna*) in two hundred elementary species independent of one another. He deserves to be considered in any case as the precursor of the ideas of which I have just given a synopsis.

It is not then in ordinary variability, as it was known up to this time, that one can, following the ideas of De Vries and Johannsen, hope to find the key to evolution, since variations can not be the starting point for permanent changes. Examining a plant (*Œnothera lamarckiana*), De Vries thought he had found this key in abrupt transformations succeeding one another in organisms, under conditions which he has not been able to determine and which remain mysterious. The abrupt and immediately hereditary variations he named *mutations* and set them in opposition to *fluctuations* (*i. e.,* common variations). According to him, evolution is not continuous but operates through mutations. The theory of mutations has been, since 1901, the occasion of an enormous number of experimental studies and of controversies, into which I shall not enter at this time, but I shall finally endeavor to extract the results won by this method of work. Let us note that, if De Vries and the mutationists do not formally deny the intervention of external factors in the production of mutations, the rôle of these factors is no longer very clearly or directly apparent, and some deny it more or less fully. In short, systematic study has led to an antithesis between *fluctuations* produced under the influence of the environment but not hereditary, and *mutations* not directly dependent upon the environment but upon heredity. We shall have to discuss the value of this distinction, the extent and the importance of mutations.

Another and very effective branch of research which has developed since 1900 and which dominates the study of biology just now, is the study of hybridization, which has led to the doctrine known as Mendelism. Sometimes the name *genetics* is specifically applied to it.

Toward 1860, the study of hybridization had led two botanists, the Austrian monk Gregor Mendel and the French botanist Naudin,[4] simultaneously but quite independently, to conceptions which did not particularly attract the attention of their contemporaries but which were brought to light again in 1900 and which then formed the starting point of very many and important investigations. The experimental study of Mendelian heredity has been carried on, especially here in Harvard, with great success by Mr. Castle on various mammals, and by Mr. East on plants. This topic therefore is familiar to the students of biology in this university. I shall speak of it for the present, only to state the general results. Let me recall to your minds as briefly as possible the essentials of Mendelism; according to this doctrine most of the properties which we can distinguish in organisms are transmitted from one generation to another as distinct units. We are led to believe that they exist autonomously in the sexual elements or *gametes,* and we can, therefore by proper crossing, group

[4] "Nouvelles Recherches sur l'Hybridité dans les Végétaux." *Nouvelles Arch. du Mus. Hist. Nat.,* Paris, Tome 1, 1865, *cf.* p. 156.

such and such properties in a single individual, or on the contrary we can separate them. The biologist deals with these unit characteristics as the chemist does with atoms, or with lateral chains, in a complex organic compound. The properties which we distinguish thus are nothing but the very indirect external expression of constituent characteristics of the fundamental living substance of the species. But we imagine, and it is in this that the enormous importance of Mendelism consists, that it has been the means of giving us a more precise idea than we have had heretofore of a substantial basis for heredity. In itself, Mendelism is only symbolism, like the atomic theory in chemistry, but the case of chemistry shows what can be drawn from a well conceived symbolism and the Mendelian symbolism becomes more perfect each day in its form, in its conception and in its application. The recent works of T. H. Morgan[5] are particularly interesting in this respect.

Further, the facts furnished by Mendelism agree well with those of cytology. The results are explained easily enough, if we accord to the chromatine in the nucleus and particularly to chromosomes, a special value in heredity. The agreement of cytology and of Mendelism is incontestably a very convincing fact and a guide in present research.

But if we return now to the study of evolution, the data of Mendelism embarrass us also very considerably. All that it shows us in fact is the conservation of existing properties. Many variations which might have seemed to be new properties are simply traced to previously unobserved combinations of factors already existing. This has indeed seriously impaired the mutation theory of De Vries, the fundamental example of the *Œnothera lamarckiana* seeming to be not a special type of variation, but an example of complex hybridization. The authors who have especially studied Mendelian heredity find themselves obliged to attribute all the observed facts to combinations of already existing factors, or to the loss of factors, a conception which seems to me a natural consequence of the symbolism adopted, but which hardly satisfies the intelligence. In any case, we do not see in the facts emerging from the study of Mendelism, how evolution, in the sense that morphology suggests, can have come about. And it comes to pass that some of the biologists of greatest authority in the study of Mendelian heredity are led, with regard to evolution, either to more or less complete agnosticism, or to the expression of ideas quite opposed to those of the preceding generation; ideas which would almost take us back to creationism.

Lamarckism and Darwinism are equally affected by these views. The inheritance of acquired characters is condemned and natural selection declared unable to produce a lasting and progressive change in organisms. The facts of adaptation are explained by a previous realization of structures which are found secondarily in harmony with varied surroundings. That is the idea which different biologists have reached and which M. Cuenot in particular has developed systematically.[6]

Two recent and particularly significant examples of these two tendencies are furnished us by W. Bateson and by J. P. Lotzy. In his "Problems of Genetics," Bateson declares that we must recognize our almost entire ignorance of the processes

[5] *Cf.* Morgan, Sturtevant, Muller and Bridges, "The Mechanism of Mendelian Heredity," New York, 1915.

[6] Cuenot, "La Genèse des espèces animales," Paris, Bibliothèque Scientifique Internationale (Alcan), 1911.—"Théorie de la préadaptation," *Scientia,* Tome 16, p. 60, 1914.

of evolution, and in his presidential address at the meeting of the British Association in Australia, in 1914, he goes so far as to express the idea that evolution might be considered as the progressive unrolling of an initial complexity, containing, from the first, within itself, all the scope, the diversity and all the differentiation now presented by living beings. As Mr. Castle cleverly expressed it, carrying the idea to its logical issue, man might be regarded as a simplified ameba, a conclusion which may well give us pause. Here we clearly recognize, on the other hand, modernized in form, but identical in principle, the conception of the "enboitement" of the germs, and of preformation, ideas to which, as I have reminded you, the eighteenth century applied the name evolution. It is a conception diametrically opposed to that of the transformism of the nineteenth century.

Mr. Lotzy, struck by the results of the crossing of distinct species of *Antirrhinum*, has reached in the last three years the conclusion that a species is fixed and that crossing is the only source of production of new forms. Hybridization among species, when it yields fertile offspring, may, according to him, give rise, all at once, to a whole series of new forms, whose mutual relations and differential characteristics correspond exactly to what the natural species show.

However subversive and delusive ideas of this kind, positive or negative, appear to generations saturated with Lamarckism and Darwinism, we must not lose sight of the fact that they were formulated by eminent biologists, and that they are the result of long and minute experimental researches and that many of the facts on which they rest may be considered as firmly established.

But without thinking of rebelling against the facts resulting from genetic studies, we may question, whether they have so general a significance. I have already more than once pointed out that the present aspect of organic heredity does not oblige us to conclude that it has always been the same. We may ask ourselves whether conditions, which have not yet been realized in experiment, do not either modify directly the germinal substance itself, or the correlation existing between the parts of the *soma*, and indirectly through them the germinal substance. The facts which the study of internal secretions are just beginning to reveal, perhaps indicate a possibility of this kind. Even if we admit that evolution proceeds only discontinuously by mutations, we still have to discover the mechanism of the production of these mutations. In short, we may believe that, with heredity and variations acting as recent researches have shown them to act, there are nevertheless conditions that are still unknown and that they have been realized for each series of organisms only at certain periods, as seems to be suggested by paleontology, and in which the constitution and properties of hereditary substances are changeable. Of course these are purely hypothetical conjectures, but such conjectures must be made if we wish to reconcile two categories of already acquired data which we are obliged to recognize as facts. On the one hand we have the results of modern genetics which of themselves lead to conceptions of fixity, and on the other hand, the mass of morphological data which, considered from a rational point of view, seem to me to possess the value of stubborn facts in support of the transformist conception. I will even go so far as to say in support of a transformism more or less Lamarckian.

It seemed to me necessary to devote the first meeting of the course to this general analysis of the conditions under which the problem of transformism now presents

itself. I believe that this analysis is the justification of the course itself. It shows the advantage of confronting in a series of lectures the old classic data with the modern tendencies, all of which have to be brought into agreement. The crisis of transformism which Le Dantec announced some eight years ago is very much more acute and more in evidence now than it was then. In making this analysis, I have been able to furnish you in advance with an outline to the following lectures which together will form four successive parts; first, a rapid examination of data contributed to the support of the transformist conception by morphology in its different aspects (comparative anatomy, embryology, paleontology); second, the examination of the principal dynamic explanations of transformism, above all Darwinism and Lamarckism; third, a study of the main principles of genetics, and fourth, a few final lectures in which we shall review all the data.

A course on evolution might seem *a priori* a hypertrophy to a program of studies, and in fact it is nothing but an extremely restricted scheme for examining important questions and the many investigations which this line of study has brought forth. All I can do, then, is to confine myself to a general view of the question, limiting myself to facts and essential data.

M. CAULLERY

SIR CLEMENTS R. MARKHAM

SIR C. R. MARKHAM, the famous geographer and explorer, who died in his London home, January 30, from burns caused by the overthrow of a candle, was in many respects a very remarkable man and his services to his fellows deserve to be widely known. He thought so little of himself that he did not trouble even to have a correct notice in "Who's Who in Science," nor did he talk or write of his own doings, so that, having survived most of his contemporaries, few were aware how much the modern world is indebted to him. Due to his sagacity and enterprise was the introduction of the quinine-producing shrub in India and the East; through his energetic work for twenty-five years as secretary to the Royal Geographical Society, and later as president, there was a vast increase in geographical knowledge and scientific exploration, whilst his published books on many diverse subjects were almost all on original ground. They would form an excellent course of study for any young man desirous to train mind and judgment on a good foundation. Each is a mine of careful research and accurate information, with utmost simplicity in presentation. There is no writing for effect and no self-exploitation; the narrative flows along easily and the reader can enjoy it as evidently the writer did.

Born in 1830, the son of the Vicar of Stillingfleet, Yorkshire, he entered the navy in 1844 and began his adventures hunting Riff pirates in the Mediterranean. In 1850, when the expedition in search of Sir John Franklin's party was preparing, he applied to join, and being refused on account of his youth, it is said that he sat down on the steps of the Admiralty and declined to move until the decision was reconsidered. Leaving in May, 1850, they returned in the autumn of 1851, having explored 300 miles of coast to about meridian 115 degrees on Melville Island, and in "Franklin's Footsteps" (published 1853), young Markham gave a spirited account of all they had seen. After wintering on Griffith Island, parties were sent in different directions over the ice, dragging by hand sledges with their limited provisions; McClintock's party covered 770 miles in 81 days, going 300 miles in a direct line from their ship. Markham was with a small party who went 140 miles in 19 days with one sledge. No wonder he spoke with genial scorn at a recent British Association meeting, of the modern polar explorer with every contrivance for comfort.

This expedition did not succeed in discovering the fate of Sir John Franklin and his crews, but it was one of twenty or more undertakings which between 1847 and 1857 went into the unknown north and turned the map of the Arctic circle from a blank into a well-charted region of desolate land and ice.

In 1852 Markham retired from the navy in order to travel and went to Peru, chiefly to study traces of the Incas. Reaching Lima from Panama, he rode on horseback along the coast south as far as Nasca, noting the wonderful Inca system of irrigation (the main trenches four feet high with roof and sides of stones) and then turned inland up to Ayacucho, and by Ollantaytambo to Cuzco. From there he went on by Paucartambo down the eastern side of the Andes and followed the course of the river Tono as far as its junction with the Purus. The Purus at that time was unexplored and there are other great blanks in the map made by Markham in 1859 for his Hakluyt edition of the early Spanish expeditions to the valley of the Amazons. In the course of this trip he learned Quichua, being at places where every one spoke that language, and he copied and studied the ancient native drama of Ollanta. Everywhere he got on well with the people, receiving hospitality in private houses, traveling with no luggage except saddlebags and making light of difficulties in the fashion of those days. He returned by sea from Islay to Lima. The pleasantly written "Cuzco and Lima" (1856) contains much general information and a chapter on Quichua grammar, a subject of study for the rest of his life. In the Introductory to the grammar and vocabulary published in 1864 he wrote:

> Ever since I was a midshipman on the Pacific station the land of the Incas has had for me an indescribable charm. I greedily devoured the pages of Prescott while anchored under the shadow of the mighty Cordilleras; and the story of the conquest and of the gentle children of the Sun, made an impression on me then, which time will never efface.

He goes on to say that, unable himself to continue the study of Quichua in the Andes, he hopes that his work may help others to make a start where he was obliged to leave off. In 1871 he published "Ollanta," from a good copy possessed by P. Justiniani (a descendant of the Incas), with an English translation. A revised translation forms the appendix to "Incas of Peru" (1910). He was assured by the natives in 1853 that the drama was undoubtedly composed before the Spaniards came:

> No European language can describe an action with anything like the precision and accuracy combined with brevity, of which Quichua is capable and the wonderfully abundant vocabulary produces great variety in composition.

This trip to Peru led to a second, for he had seen the shrub of the Peruvian bark and its use for malarial fever, and urged its introduction into India.[1] The Secretary of State for India consequently charged him with this important mission and in "Travels in Peru and India" (1862), he described his successful efforts. The Ecuador forest region he entrusted to R. Spruce,[2] who searched the western slopes of Chimborazo, took 1,000 cuttings and made a large number grow. He also collected seeds after carefully watching them ripen. Pritchett was told to collect in Huanuco and Markham himself reached Islay in March, 1860, and went first to Puno in the hope of interesting the Bolivian government but found opposition to any plan that might interfere with the local monopoly. He therefore went down to the Montaña over Peruvian ground by the Tambopata valley to Sandia in Caravaya, with Weir, a collector. There he found three desirable species, *C. micrantha* growing nearest the river, *C. Calisaya* in a zone above and *C. ovala* in a third zone, six to eight hundred feet above the river. He brought away 529 plants of six species, chiefly *C. Calisaya* and *C. morada,* returned safely by Lima and Panama to England and thence conveyed his precious cargo to India and the

[1] It was then excessively costly, as the collectors cut down the trees to get the bark.

[2] See Spruce's "Diary," edited by Alfred Wallace, 1908.

Neilgherry Hills. Successful production of quinine in India and distribution of seedlings all over Burmah and Ceylon reduced the cost so that it could be used by all. Of late years an artificial imitation has been used in the western world and can not be so beneficial. A similar tree with medicinal bark grows in Yucatan and at Cordoba in Mexico.

In the interesting preface to "Conquest of New Granada" (1912), Markham says that he found valuable drawings of the cinchona plants of Colombia by Mutis, in the toolhouse of the Botanic Garden at Madrid and obtained leave for their publication, edited by J. Triana.[3] He afterwards employed Cross to explore the region of *C. Pitayensis* in Colombia, east of Popayan and Timaná, and in 1867 published a translation of the works of Mutis and Karstan on the cinchona genus; also a handbook in Spanish for the use of cultivators.

Having joined the Royal Geographical Society in 1854, he became honorary secretary to the Hakluyt Society in 1858 and thenceforth some of his time was occupied in research for suitable manuscripts that he edited and in most cases translated from old Spanish, no small task. He was private secretary to the Under Secretary of State for India, 1862–64, and in 1865 was sent to Ceylon to report on the pearl fisheries. A military expedition to Abyssinia becoming necessary to rescue the British consul and other captives, Markham was sent as geographer, accompanying the troops to Magdala. In the "History of the Abyssinian Expedition" (1869), he gives admirable descriptions of the people, the geology and natural history of the land, with maps.

From 1863 to 1888, as secretary of the Royal Geographical Society, he had special opportunities to keep polar enterprises before the public. Through his indomitable energy the Nares expedition was fitted out in 1874 and he accompanied it as far as Greenland. He originated and promoted another expedition in 1875–76, when Commander D. Markham succeeded in reaching latitude 83 degrees, 20 minutes and 22 seconds, the highest northern position achieved up to that time. He also worked hard to obtain funds for Captain Scott's first expedition; the tragic end of Scott's party materially shortened his life. African exploration owed much to his encouragement of the pioneers who during the sixties endeavored to reach the sources of the Nile and discovered the great lakes, and at the British Association of 1864 he brought together Livingstone, Speke, Burton, Grant, Kirk and Sir Samuel Baker. Through him the Royal Geographical Society has been of untold benefit to scientific explorers by providing them with skilled instruction in nautical astronomy and surveying, etc. His address on the fiftieth anniversary of the society and the Review of Geography in his "Life of Major Rennell" (founder of modern geography), show the advance of the science until it has seemed to have no more worlds to conquer; for many years he was its inspiration and it took new force and meaning under his guidance.

The Hakluyt Society too has done excellently under him, bringing out many good editions of valuable old works of travel. In his address on the fiftieth anniversary in 1896, Sir Clements said:

> Our editors work gratuitously and for mere love of their authors. Every volume has an introduction and is annotated so as to give the reader all the help he can require in the study of the text.

Continuing with a graceful reference to the United States "whence we receive so much and such generous support," he added:

> The well-being of the Hakluyt Society is a symptom and not an insignificant one, of healthy tendencies of thought and healthy aspirations among the peoples who speak the English language.

The Founder's Medal of the Royal Geographical Society was bestowed on him in 1888; he was president from 1893 to 1906, remaining as vice-president to 1912; was also president of the International Geographical Congress, 1895–99; admitted as F.R.S., in

[3] "Nouvelles études sur les quinquina," Paris, 1870.

1873, and as F.S.A. about the same time and was president of the Hakluyt Society from 1889. In 1896 he was given the K.C.B., and other honors included a grand prix at the Paris Exposition of 1867 for the introduction of the cinchona cultivation into India; the order of the Rose from the emperor of Brazil, and of Christ from the king of Portugal. He married in 1857 a lady of the ancient family of Chichester. It is remarkable that the two branches of the family, both living in Devon, have never intermarried since the reign of Edward the Second, about 1310.

With Lady Markham he attended the meetings of the International Congress of Americanists at Stuttgart (1904) and Vienna (1908), and as president of the eighteenth congress (London, 1912), his support was most generous and energetic. He had hoped to take part in the nineteenth congress, held in Washington, December 27–31, 1915, for his heart was always drawn towards South American research, and he desired to aid it as far as possible. In a written message to members of the congress, he said:

> I regret extremely to be unable to attend, for I am deeply impressed with the great value and importance of these meetings. They are intended, as one main object, to supply to the minds of young explorers and students the best methods of obtaining accurate information and of using it when obtained. I think it should be impressed upon the rising generation of Americanists that study alone is insufficient for securing really satisfactory results; and that exploration and the collection of antiquities is not enough. The two branches must be combined. The study and use of authorities is by far the most difficult. In using them the character of the authority to be used must be carefully considered as well as his opportunities and his date. One great stumbling block for young students, whether in the study or in the field, is the adoption of a theory, leading to the search for its support. . . . A true worker should have no theory.
>
> I wish to submit my view to the congress that there is a splendid field for almost a life work in a study of the ancient civilization in the Peruvian coast valleys from Tumbez south. As yet it has not been touched by any one who is alike a diligent student with a profound knowledge of all that has been written in the past, together with the surveying, architectural and mechanical acquirements needed for a thorough examination of all that is to be found on the spot, and in museums. . . . I look upon a complete and thorough investigation of the history of the Chimu kingdom as one of the chief Americanists' desiderata.

Sir Clements Markham's life was full of achievements, such as would have been possible only to one fitted with extraordinary power and versatility. To have established in India and throughout the East, as he did, the cultivation of a prophylactic for the desolating malarial disease was a great service to humanity. Of boundless enthusiasm and tenacity of purpose, his ambitions were of the highest type, and his appreciation of the efforts of others to reach the points at which he aimed, was generous to the extreme. He was indeed a man in whom his countrymen could discern the best and most sterling qualities of their race.

A. C. B.

PRINCIPAL CAUSES OF DEATH IN THE UNITED STATES

According to a preliminary announcement with reference to mortality in 1914, issued by Director Sam. L. Rogers, of the Bureau of the Census, Department of Commerce, and compiled by Mr. Richard C. Lappin, chief statistician for vital statistics, more than 30 per cent. of the 898,059 deaths reported for that year in the "registration area," which contained about two thirds of the population of the entire United States, were due to three causes—heart diseases, tuberculosis and pneumonia—and more than 60 per cent. to eleven causes—the three just named, together with Bright's disease and nephritis, cancer, diarrhea and enteritis, apoplexy, arterial diseases, diphtheria, diabetes and typhoid fever.

The deaths from heart diseases (organic diseases of the heart and endocarditis) in the registration area in 1914 numbered 99,534, or 150.8 per 100,000 population. The death or mortality rate from this cause shows a marked increase as compared with 1900, when it was only 123.1 per 100,000.

Tuberculosis in its various forms claimed 96,903 victims in 1914, of which number 84,366

died from tuberculosis of the lungs (including acute miliary tuberculosis). As a result of a more general understanding of the laws of health, the importance of fresh air, etc., due in part, no doubt, to the efforts of the various societies for the prevention of tuberculosis, there has been a most marked and gratifying decrease during recent years in the mortality from this scourge of civilization. In only a decade—from 1904 to 1914—the death rate from tuberculosis in all its forms fell from 200.7 to 146.8 per 100,000, the decline being continuous from year to year. This is a drop of more than 25 per cent. Prior to 1904 the rate had fluctuated, starting at 201.9 in 1900. Even yet, however, tuberculosis has the gruesome distinction of causing more deaths annually than any other form of bodily illness except heart diseases, and over 40 per cent. more than all external causes—accidents, homicides and suicides combined.

Pneumonia (including bronchopneumonia) was responsible for 83,804 deaths in the registration area in 1914, or 127 per 100,000—the lowest rate on record. The mortality rate from this disease, like that from tuberculosis, has shown a marked decline since 1900, when it was 180.5 per 100,000. Its fluctuations from year to year, however, have been pronounced, whereas the decline in the rate for tuberculosis has been nearly continuous.

The only remaining death rate higher than 100 per 100,000 in 1914 was that for Bright's disease and acute nephritis, 102.4. The total number of deaths due to these maladies in 1914 was 67,545, more than nine tenths of which were caused by Bright's disease and the remainder by acute nephritis. The mortality from these two causes increased from 89 per 100,000 in 1900 to 103.4 in 1905, since which year it has fluctuated somewhat.

Next in order of deadliness comes cancer and other malignant tumors, which filled 52,420 graves in 1914. Of these deaths, 19,889, or almost 38 per cent., resulted from cancers of the stomach and liver. The death rate from cancer has risen from 63 per 100,000 in 1900 to 79.4 in 1914. The increase has been almost continuous, there having been but two years—1906 and 1911—which showed a decline as compared with the years immediately preceding. It is possible that at least a part of this indicated increase is due to more accurate diagnoses and greater care on the part of physicians in making reports to registration officials.

Diarrhea and enteritis caused 52,407 deaths in 1914, or 79.4 per 100,000. This rate shows a marked falling off as compared with the rate for the preceding year, 90.2, and a very pronounced decline as compared with that for 1900, which was 133.2. Nearly five sixths of the total number of deaths charged to these causes in 1914 were of infants under 2 years of age.

Apoplexy was the cause of 51,272 deaths, or 77.7 per 100,000. The rate from this malady has increased gradually, with occasional slight declines, since 1900, when it stood at 67.5.

Arterial diseases of various kinds—atheroma, aneurism, etc.—caused 15,044 deaths, or 22.8 per 100,000, in the registration area.

No epidemic disease produced a death rate as high as 18 per 100,000 in 1914. The fatal cases of diphtheria and croup—which are classed together in the statistics, but practically all of which are of diphtheria—numbered 11,786, or 17.9 per 100,000, in that year, the rate having fallen from 43.3 in 1900. This decline of nearly 59 per cent. is relatively greater than that shown by any other important cause of death. The rate has not fallen continuously, but has fluctuated somewhat from year to year.

Diabetes was the cause of 10,666 deaths, or 16.2 per 100,000. The rate from this disease has risen almost continuously from year to year since 1900, when it was 9.7 per 100,000.

The mortality rate from typhoid fever has shown a most gratifying decline since 1900, having decreased from 35.9 per 100,000 in that year to 15.4 in 1914, or by 57 per cent. This decline has been almost as great, relatively, as that for diphtheria, and has been greater than that for any other principal cause of death. The total number of deaths due to typhoid fever in 1914 was 10,185. The marked decrease in the mortality from this disease gives emphatic testimony to the effectiveness of

present-day methods, not only of cure, but of prevention. The efficacy of improved water-supply and sewerage systems, of the campaign against the fly, and of other sanitary precautions is strikingly shown by the reduction of the typhoid mortality rate to the extent of more than five ninths in 14 years.

The principal epidemic maladies of childhood—whooping-cough, measles and scarlet fever—were together responsible for no fewer than 15,617 deaths of both adults and children, or 23.7 per 100,000, in the registration area in 1914, the rates for the three diseases separately being 10.3, 6.8 and 6.6, respectively. In 1913 measles caused a greater mortality than either of the other diseases, but in 1914 whooping-cough had first place. In every year since and including 1910, as well as in several preceding years, measles has caused a greater number of deaths than the much more dreaded scarlet fever. The mortality rates for all three of these diseases fluctuate greatly from year to year. The rates for measles and scarlet fever in 1914 were the lowest in 15 years, while that for whooping-cough was considerably above the lowest recorded rate for this disease, 6.5 in 1904, although far below the highest, 15.8 in 1903.

Deaths due to railway accidents and injuries totaled 7,062, or 10.7 per 100,000. This number includes fatalities resulting from collisions between railway trains and vehicles at grade crossings. The death rate from railway accidents and injuries is the lowest on record and shows a most marked and gratifying decline as compared with the rate for 1913, which was 13 per 100,000, and a still more pronounced drop from the average for the five-year period 1906–10, which was 15 per 100,000.

Deaths resulting from street-car accidents and injuries numbered 1,673, or 2.5 per 100,000. This rate, like that for railway fatalities, is the lowest on record and shows a material falling off as compared with 1913, when it was 3.2, and as compared with the average for the five-year period 1906–10, which was 3.7.

The number of suicides reported in 1914 was 10,933, or 16.6 per 100,000 population. Of this number, 3,286 accomplished self-destruction by the use of firearms, 3,000 by poison, 1,552 by hanging or strangulation, 1,419 by asphyxia, 658 by the use of knives or other cutting or piercing instruments, 619 by drowning, 225 by jumping from high places, 89 by crushing, and 85 by other methods.

SCIENTIFIC NOTES AND NEWS

A supper will be given by the Harvey Society in honor of Dr. William H. Welch following his lecture upon Medical Education before the society on April 29. The supper will be given in Sherry's ballroom.

Oscar T. Schultz, M.D., professor of bacteriology and pathology in the University of Nebraska College of Medicine, Omaha, has been made director of the Nelson Morris Memorial Institute for Medical Research, Chicago. Max Morse, Ph.D., assistant professor of biochemistry in the college, has been appointed associate in chemistry in the institute.

R. E. Coker, Ph.D. (Johns Hopkins, '06), for several years director of the United States Fisheries Station for pearl-mussel investigation at Fairport, Iowa, has been promoted to be head of the division of scientific inquiry in the Bureau of Fisheries at Washington.

Dr. D. H. Scott, F.R.S., professor of botany in the London Royal College of Science, has been elected a foreign member of the Royal Swedish Academy of Sciences, in succession to the late Count Solms-Laubach.

The Founder's medal of the Royal Geographical Society has been awarded to Lieutenant-Colonel P. H. Fawcett, for his explorations and surveys on the upper waters of the Amazon; and the Patron's medal to Captain F. M. Bailey, Indian Army, for his exploration of the Tsangpo-Dihang River in the hitherto almost unexplored country where it breaks through the Himalayas. The Murchison award has been made to Lieutenant-Colonel Whitlock, R.E., for his work in connection with the delimitation of the Yola-Chad boundary in 1903–5, and the Yola Cross River boundary in 1907–9; the Back award to Mr. Frank Wild, second in command of Sir Ernest Shackleton's transcontinental Antarctic Expe-

dition, for his long-continued services in the exploration of Australia; the Cuthbert Peek award to Mr. F. Kingdon Ward for his journeys in the frontier regions between China and Burma, and to assist him in the further exploration of those regions; the Gill Memorial to Lieutenant-Colonel E. M. Jack, R.E., for his service in the delimitation and demarcation of the Uganda-Congo boundary.

As has been noted here the Nichols medal, awarded by the New York Section of the American Chemical Society for the best original contribution to the publication of the society during the year 1915, was conferred upon Dr. Claude Silbert Hudson, of the Bureau of Chemistry, in recognition of his research in the field of organic chemistry, at the regular meeting of the section, in Rumford Hall, Chemists' Club, March 10, 1916. In presenting the medal Dr. T. B. Watson, chairman of the New York Section of the society, quoted the specific character of chemical research represented by the different awards of the William H. Nichols medal in past years:

1903—Agricultural chemistry, E. B. Voorhees.
1905—Rare earths, C. L. Parsons.
1906—Organic chemistry, M. T. Bogert.
1907—Analytical chemistry, H. B. Bishop.
1908—Chemical engineering, W. H. Walker.
1908—Physical chemistry, W. A. Noyes and H. C. P. Weber.
1909—Organic chemistry, L. H. Baekeland.
1911—Physical chemistry, M. A. Rosanoff and C. W. Easley.
1912—Organic chemistry, C. James.
1914—Organic chemistry, M. Gomberg.
1915—Physical chemistry, I. Langmuir.

THE New York *Medical Record* states that the trustees of the New York Medical College and Hospital for Women gave a luncheon at Delmonico's on April 8 in honor of the fiftieth anniversary of the graduation of Dr. Anna Manning Comfort, the only surviving member of the first class graduated from the college. Dr. Comfort and Mr. Jefferson Levy, one of the incorporators of the institution, were the guests of honor. At the commencement exercises of this first class addresses were made by Henry Ward Beecher, Peter Cooper, Horace Greeley, Lucretia Mott, Elizabeth Cady Stanton and Dr. Lozier, dean of the college. The endowment of a scholarship at the college, to be known as the Anna Manning Comfort scholarship, was announced at the luncheon.

DR. CARLOTTA J. MAURY will make a paleontological expedition to the Island of Santo Domingo to study the Tertiary paleontology and stratigraphy, making collections and sections. This work will be carried on by the Sarah Berliner endowment. Dr. Maury has also been appointed special lecturer in paleontologic research at Cornell University for 1916–1917 on the Sarah Berliner Foundation.

THE University of Notre Dame has conferred the Lætare medal this year on Dr. James J. Walsh, author of publications on the history of science.

WE learn from *Nature* that at the University of Cambridge the Smith's prizes are awarded to H. M. Garner, St. John's College, for two papers on orbital oscillations about the equilateral triangular configuration in the problem of three bodies, and to G. P. Thomson, Corpus Christi College, for four papers on aeroplane problems. A Rayleigh prize is awarded to W. M. Smart, Trinity College, for an essay on the libration of the Trojan planets.

DR. L. JOST, professor of botany, has been elected rector of the university at Strassburg.

AT its meeting held on April 12, the Rumford Committee of the American Academy of Arts and Sciences voted a grant of $100 in addition to a former appropriation to Professor Frederick Palmer, Jr., of Haverford College, in aid of his research on the properties of light of extremely short wave-length.

DR. CHARLES WEISMAN, of the United States Public Health Service, has been transferred to Pittsburgh, which is the new headquarters of the service for work on industrial hygiene.

W. F. HORTON, mining technologist of the Bureau of Mines, has resigned to accept services with a steel company.

DR. H. H. MITCHELL has been appointed epidemiologist to the Indiana State Board of Health.

A. W. Richter, dean of engineering at the Montana State College, was elected president of the Montana Society of Engineers at the annual meeting which took place at Helena on April 7 and 8.

The 722d meeting of the Philosophical Society of Washington will be held at the Cosmos Club, on April 20, when the address of the evening will be by Dr. R. A. Millikan, of the University of Chicago, on "Some Recent Aspects of the Radiation Problem." Members of the American Physical Society are invited to attend this meeting, which will be followed by a social hour.

At the regular monthly meeting of the Cosmos Club, Washington, held on April 10, Dr. W. T. Swingle delivered an address on "Impressions of a Visit to Japan."

Dr. Frederick H. Getman delivered a lecture on the "Nature of the Chemical Elements" before the Science Club of Wellesley College on April 11.

Professor W. S. Franklin delivered a lecture on "Electric Waves" before the department of Electrical Engineering of the University of Illinois on April 6. He also spoke before the Physics Club on "Some Mechanical Analogies in Electricity and Magnetism." Two other lectures were given by Professor Franklin, one on the "Curved Flight of a Baseball" and the other on "Bill's School and Mine."

Professor Liberty H. Bailey, of Ithaca; Dr. Ernest Burnham, of Kalamazoo; President Kenyon L. Butterfield, of the Massachusetts Agricultural College, and Professor E. R. Groves, of the New Hampshire College, will deliver courses of lectures at the summer graduate school of the Association of American Agricultural Colleges and Experiment Stations which will be held this year at Amherst, Mass., at the Massachusetts Agricultural College.

The anniversary meeting of the British Chemical Society was held on March 30, when Dr. Alexander Scott delivered his presidential address, entitled "Our Seventy-fifth Anniversary."

Dr. William Palmer Bolles died at Santa Barbara, Cal., on March 18. He was professor of materia medica and botany in the Massachusetts College of Pharmacy from 1874 to 1884, and instructor in materia medica and therapeutics in the Harvard Medical School from 1880 to 1884. He was until his retirement in 1908 surgeon at the Boston City Hospital.

UNIVERSITY AND EDUCATIONAL NEWS

With the exception of chemistry, all the departments of the Johns Hopkins University will be transferred to Homewood by October, 1916. The Johns Hopkins Club has contracted to take over the Carroll House on the Homewood campus.

By the will of the late Colonel E. A. Knox the New York Medical College and Hospital for Women receives a bequest of $5,000.

Dr. E. D. Ball, director of the experiment station and school of agriculture of the Utah Agricultural College has resigned to take effect at the end of the present year. Dr. Ball plans to go back into entomological work. Dr. F. S. Harris, professor of agronomy, has been elected director of the experiment station, and Dr. G. R. Hill, professor of botany and plant pathology, director of the school of agriculture.

Dr. Nellis B. Foster, assistant professor of medicine at Cornell University Medical School, has accepted the appointment of professor of medicine at the University of Michigan, Ann Arbor.

Dr. Frank Worthington Lynch, formerly associate professor of obstetrics at the University of Chicago, has been made full professor of obstetrics at the University of California, succeeding J. Morris Slemons, 1900, who has accepted a similar chair at Yale.

Dr. Ernest Laplace, who has been professor of surgery and clinical surgery in the Medico-Chirurgical College, Philadelphia, for the last twenty years, has accepted also the duties of professor of principles of surgery and clinical surgery held by the late Dr. Rodman.

GARRETT RYLAND, Ph.D. (Johns Hopkins, '98), has been made professor of chemistry at Richmond College, Richmond, Virginia.

MR. A. V. HILL, Humphrey Owen Jones lecturer in physical chemistry at the University of Cambridge, has been elected a fellow of King's College.

MR. F. P. WHITE, St. John's College, has been elected to an Isaac Newton studentship at the University of Cambridge.

PROFESSOR SIEGFRIED GARTEN, of Giessen, has been called to the chair of physiology at Leipzig as successor to Professor E. Hering.

DISCUSSION AND CORRESPONDENCE

THE CURRENT "DEFINITION" OF ENERGY

TO THE EDITOR OF SCIENCE: In a book review by Professor Millikan[1] the reviewer incidentally mentions the existing confusion in the use of the word "energy." In my judgment, Professor Millikan's remark is fully justified; for it is not only the writers of text-books, but scientific writers of the first rank who find themselves more or less entangled with the current definition of energy and the terminology to which the definition leads because the terminology is inconsistent with a logical use of the facts. Recent and present writers are not wholly to blame for this state of affairs for they have inherited a "definition" and a terminology from the pioneers in the science of thermodynamics that conflict with facts whose full significance was discovered only after the terms were introduced and their use established. Under such circumstances confusion is inevitable until the terminology is revised to fit the facts.

Many of our text-books on physics "define" energy as the "capacity of doing work" (Maxwell), as the "ability to do work," or, even as the "power of doing work." This last is particularly reprehensible, because "power," as used in physics, is the rate of doing work. As a matter of fact, even if work were a form of energy, none of these definitions would be an adequate "definition" of energy any more than a quart measure would be a definition of "space." Because heat is a form of energy it does not follow that "energy is heat," or, because our standard of mass is a piece of platinum that "matter is platinum." But the above definitions of energy are worse even than the above logical absurdities would indicate, for work, as may easily be seen, is not even a form of energy, like heat, but is in reality merely a phenomenon that accompanies its transfer or transformation. The reason why our unit of work is also our unit of energy is that all of our measurements of work are *energy-changes* involving transfers which may be *measured* by the work done *on* or *by* a body or system. The actual doing of work is always found to depend upon the existence of *energy differences;* and these *differences* are just as essential to the doing of work and the transfer of energy as the presence of energy itself. This fact, which is ignored in the above definitions, is expressed in a variety of ways by the second law of thermodynamics. "The capacity of doing work," if the words are to mean anything definite should be taken as referring to the "availability of energy"; and the *availibility* of a thing is not the *thing* available. In explaining work and energy, Professor Millikan states:[2]

> . . . it is obvious that they are not synonymous terms, for a body may possess energy and yet never apply it to the production of work. Work is done only when energy is *expended.*

If he had here used the word "transferred" instead of "expended" his statement would confirm what I have been endeavoring to present.

There is no more necessity for a "definition" of energy than there is for a definition of "matter." Both are known only by their characteristic phenomena; and these characteristics must serve to identify them and to differentiate them from each other. With the "units" of each, however, the case is quite different. They may be defined in terms of

[1] SCIENCE, October 2, 1914, p. 486.

[2] "Mechanics, Molecular Physics and Heat," p. 42.

any *constant,* suitable, measurable, characteristic, phenomena. We do not have to "define" space because we have units of volume, or extension because we make use of meters, yards and feet. Next to an ignorance of facts, the principal source of confusion in the case of energy arises from using *one* characteristic attribute, and that not a universal one, as a "definition" of energy. Through supposing the indefinable to *be* defined, even the most careful writers are led into inconsistencies and mis-statements. The result, to the alert and critical student, is "confusion worse confounded." It does not follow that because our unit of work furnishes a very convenient and definite unit of energy that it is possible to "define" energy, or that work is a kind of energy. There is only one fundamental and universal characteristic of energy which we can be sure holds true for all of its various forms and that is its conservation. Energy is conserved; and this, if merely regarded as a postulate, necessitates our recognizing that when one form of it disappears another form takes its place. Equivalents of both can not exist at the same time. Hence, if work is a kind, or form, of energy it must possess and exhibit this characteristic, that while it exists in the form of work some other form must cease to exist, and *vice versa.* It can not be too strongly insisted upon that the property, or attribute, of conservation necessarily excludes all processes not included under transference and transformation. Again, although energy changes may be measured in terms of work the principle of conservation applies only to the energy; and it becomes possible to prove this principle only through the existence of some *one universal* form of energy into which all other kinds may be transformed. For it is evident that if there is no universal form there must be for each form, or kind, some special means by which it may be identified as energy and its equivalent value measured; otherwise the "principle of conservation" is a mere delusion, or purely imaginary. But so far as is now known all forms of energy without exception are susceptible to transformation into heat, either directly or indirectly through work, and their energy values determined in terms of heat. Hence for the present, at least, heat may be regarded as the universal form of energy.

In order to establish, definitely, the relation between heat and energy let us consider for a moment Joule's classical experiments for the determination of the mechanical equivalent of heat. The potential energy of the elevated weights *disappeared* during their descent and produced a quantity of heat which was measured. Now, by the principle of conservation, potential energy could be imparted to the weights only by the *disappearance somewhere* of an equivalent, either of heat, or of some potential form of energy. In either case, the elevated weights represented energy that has been accounted for without counting work *as energy;* hence the work done in elevating them can not have been energy. Nor is it in the case of the descending weights; for the potential energy of the descending weights disappears as potential energy and reappears as heat. *Work is then,* it can be seen, *a kind of process by means of which energy is transferred and transformed.*

Doubtless many will find it difficult to understand how the unit of work can be a correct and convenient unit of energy and yet not *be* energy. A parallel case is found in the measurement of temperature. The indications of the thermometric substance are due to heat yet are not heat; they must be interpreted as *ratios,* and merely show the relation of the temperature measured to some temperature assumed as a standard. Likewise a standard energy state is assumed and the *change* in the energy of the system may be measured by the work done *on* or *by* the system, an *inverse* corresponding change taking place in some other body or system. From the fact that the ratio of the work unit to the heat unit (energy) is known, the energy *change* is readily obtained by applying the ratio.

Since in teaching, concise, definite statements are desirable whenever possible, the current, defective and misleading "definitions" might be replaced by short statements like the following:

All physical phenomena are *effects* attributed to a universal activity called energy.

Since energy is conserved, or constant in amount, all of our experimental observations of it are limited to the various effects due to its transfer and transformations.

The doing of work indicates the transfer of energy (Maxwell).

All spontaneous natural processes may be made to do work (Nernst).

Transformations of energy take place accompanied by, or during, transfer.

Since writers of text-books and other writers who necessarily depend more upon authority than upon their own investigations and interpretations can doubtless quote the necessary "good authority" for their principal statements, when such statements are questioned, they will pay but little attention to adverse criticism so long as they have the necessary authority for their statements. This being only natural and reasonable, the foregoing view regarding the use and misuse of the words "work" and "energy" shall also be supported by quoting the necessary "high authority," Professor Clerk-Maxwell. All of the following quotations will be taken from two of his well-known and justly prized books, "Theory of Heat," tenth edition, which will be referred to as T. of H., and his "Matter and Motion," which will be referred to as M. and M. In addition to being a scientific investigator and mathematician of the first rank Professor Maxwell possessed a remarkable ability as a scientific writer and expositor.

The use of the term energy, in a scientific sense, to express the quantity of work a body can do, was introduced by Dr. Young (T. of H.), p. 91.

Dr. Young wrote at a time when the conservation of energy was yet unthought of. Hence Professor Maxwell "inherited" the definition—did not originate it. The inconsistencies in the following excerpts may safely be attributed to the growth of the subject and the failure of the later parts to agree with the older parts. A considerable part of the growth of the subject was due to the labors of Professor Maxwell himself.

For the energy of a body may be defined as the capacity it has of doing work, and is measured by the quantity of work it can do (T. of H., p. 90).

Energy is the capacity of doing work (M. and M., p. 101).

Perhaps those writers who "define" energy are not so much to blame, after all! They have, at least, "good authority." There could be no exception taken to the first statement if it confined itself to the following: "The energy of a body may often be measured by its capacity of doing work," *i. e.*, to transfer its energy; but there is no warrant for the last sweeping generalization that "energy is the capacity of doing work." It is indeed a striking example of a very common human trait—a tendency to repeat current familiar phrases without critical examination. Everybody does it more or less. All that the facts which he presented warranted him in claiming was that the capacity of doing work *is due to energy,* or, that *one important characteristic* of energy is its capacity of doing work, *i. e.*, of bringing about its own transfer.

Here then we have two sets of quantities, one relating to work, the other to heat. . . .

Of these quantities work and heat are simply two forms of energy (T. of H., p. 194).

It should be noted here that work is spoken of as a "form of energy."

The potential energy of a material system is the capacity it has of doing work depending on other circumstances than the motion of the system (M. and M., p. 120).

The preceding excerpts are sufficient to show the influence of Dr. Young's definition of energy. Some quite different statements as to the relation of work and energy will now be given—evidently the result of Professor Maxwell's own study of the subject, but whose full significance he did not then realize, or live to complete.

Work, therefore, is a transference of energy from one system to another; the system which gives out energy is said to do work on the system which receives it, and the amount of energy given out by the first system is always exactly equal to that received by the second (M. and M., p. 104).

Now it is evident as soon as the attention is called to it that work can not, at the same time, be both energy and the transference of energy. If two statements are inconsistent, one, at least, must be abandoned. Let us see which.

A similar inconsistency, or contradiction, is found in two recent, excellent, text-books, both by the same author, who quotes freely from Maxwell. In one book we find that "*energy is the capacity for doing work*," while in the other book it is stated that "work may now be defined as the act of *transferring energy* from one body or system to another." If we combine these two statements in one we find that energy is the capacity for transferring energy!

The conflict evidently arises from retaining the old definition of Dr. Young which was introduced before the principle of conservation was recognized. It should be abandoned as no longer applicable. (See discussion of Joule's experiment given above, and the conclusion derived from it.)

In order to show that the last excerpt from Maxwell is not a mere slip of the pen but a conclusion based on evidence two additional excerpts will be given.

> The process by which stress produces change of motion is called work, and, as we have already shown, work may be considered as the transferance of energy from one body or system to another (M. and M., p. 164).

> The transactions of the material universe appear to be conducted, as it were, on a system of credit. Each transaction consists of the transfer of so much credit or energy from one body to another. This act of transfer or payment is called work. The energy so transferred does not retain any character by which it can be identified when it passes from one form to another (M. and M., p. 166).

We have, then, a conflict of authority from the *same source* and we must, perforce, decide from the evidence and not on the authority, and that is decidedly in favor of the later and consistent view that work is a transference of energy and not a "form of energy." The authors of text-books have just as good authority, if they care to use it, for defining work as a process of transference of energy as they have for defining energy as "the capacity of doing work"; and by so doing can place themselves more nearly in touch with recent developments as to what constitutes the relation between work and energy.

We have had one "definition" of energy; the following statement, by way of contrast, might also be used as another.

> Hence, as we have said, we are acquainted with matter only as that which may have energy communicated to it from other matter, and which may, in its turn, communicate energy to other matter.
>
> Energy, on the other hand, we know only as that which in all natural phenomena is continually passing from one portion of matter to another (M. and M., p. 165).

This latter, and later, conception of energy seems, to my mind, a long step in advance over the conception of energy as the "capacity of doing work." In addition, it is in full accord with the later developments of our knowledge of energy and with the general principle of conservation.

If we *accept* the conservation of energy as an established *principle*, then we must accept the legitimate deductions from it or abandon it as a principle. It is plain that neither the view that energy is a capacity of doing work, nor the view that makes work a "form of energy" is consistent with considering work a *transference* of energy; and also that while the last view is consistent with the principle of conservation the other two are not. The consistent view, and to that extent at least, the true view is, so far as my knowledge goes, the personal contribution of Professor Maxwell. No earlier, or contemporary writer, so far as I know, and they are not numerous, makes such definite and specific generalized statements. His treatment of energy in "Matter and Motion" is a distinct advance over his treatment of it in his "Theory of Heat." No doubt that if he had lived a few years longer he would have renewed his study of energy and cleared up his apparent inconsistencies. His later years were devoted

mainly to his "Electromagnetic Theory of Light," "one of the most splendid monuments ever raised by the genius of a single individual." All of the early investigators in the theory of energy received a peculiar bias from the fact that the theory of energy was developed from the theory of work—the production of "useful work" being one of the most important problems in the life of nations as of men. Hence the statement that "energy is the capacity of doing work" was evidently received and accepted by scientific men before and during Maxwell's time as expressing an advanced scientific generalization; and even now, when not too critically examined, might pass as equivalent to the statement: Energy is the universal natural agency by means of which work is done. But while the former statement is logically weak and leads to ambiguities and contradictions the latter statement is perfectly definite, consistent with Maxwell's showing that work is a transference of energy and with that broad general principle, the conservation of energy.

M. M. GARVER

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A PECULIAR BREED OF GOATS

TO THE EDITOR OF SCIENCE: There is a peculiar breed of goats raised in central and eastern Tennessee. When suddenly frightened the hind legs become stiff and the animal jumps along until it recovers and trots off normally or if greatly frightened the front legs become stiff also and the goat falls to the ground in a rigid condition. They have received the name of "stiff-legged" or "sensitive" goats.

The farmers in Tennessee prefer them because they do not jump fences. They are snow white and look like ordinary goats.

We are starting experiments to determine whether this is a dominant or recessive characteristic in comparison with a normal goat.

When this peculiar affliction first appeared I can not say, but it seems to be possessed by all the goats in the section named.

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SCIENTIFIC BOOKS

The Natural History of Hawaii: Being an Account of the Hawaiian People, the Geology and Geography of the Islands, and the Native and Introduced Plants and Animals of the Group. By WILLIAM ALANSON BRYAN, Professor of Zoology and Geology in the College of Hawaii. Honolulu, Hawaii, The Hawaiian Gazette Co., Ltd. 1915. Distributors, H. S. Crocker & Co., 565 Market Street, San Francisco; G. E. Stechert & Co., 151 West 22d Street, New York. Price $5.50.

In 1907 and 1908 the American Association for the Advancement of Science thought seriously of going to Hawaii in the near future for a summer meeting. Prominent citizens of Hawaii joined the association in anticipation of this visit, and invitations from Hawaiian institutions were received in number. The then governor of the Islands, Mr. Frear, called on the Permanent Secretary in Washington, and Professor W. A. Bryan, of the College of Hawaii, attended the Chicago and Dartmouth meetings of the association in 1908, urging the mid-Pacific meeting. But difficulties of transportation arose, and the plan was finally abandoned at least until some future date. Professor Bryan's effort, however, was not without result, since during his visit he gained his charming wife, and has now brought out his great book on the natural history of Hawaii, thus bringing the islands to the continental members of the association to console them for the abandonment of the Hawaiian meeting.

Practically alone among the great scientific societies in this country, the American Society of Naturalists has preserved in its title the old idea of natural history. The old natural history is still talked about and written about, while the old natural philosophy, so-called, has gone out. But the old-fashioned natural history books, with their great charm and interest to a large class of readers, are seldom published nowadays.

This book of Professor Bryan's, however, is a real natural history. It covers in its six hundred pages the whole field. Section I.,

with its seven chapters, treats of the Hawaiian people, telling of the coming of the Hawaiian race, the effect of the tranquil environment of the islands upon the people, discussing also their physical characteristics and their culture in a broad way. Section II., with fourteen chapters, treats of the geology, geography and topography of the islands, including two chapters on the world's greatest active volcano, Kilauea. Section III. gives a consideration of the flora of the islands, devoting one chapter to the plant life of the seashore and the lowlands, and the other to the vegetation of the high mountains. Section IV. is on agriculture and horticulture in Hawaii, with four chapters. All of this portion of the volume is included in what is termed "Book I." Book II., in the same volume, considers the animal life of the group and devotes seventeen chapters to its consideration.

Of course the field covered is so great that the author can not pretend to speak authoritatively on all points, but he has carefully studied the writings of the many experts who have written about the differing topics, and acknowledges the assistance of many naturalists. But all information has been sifted and studied by the author who for many years has led an active naturalist's life in the islands.

The volume is elaborately illustrated with half-tones from original photographs, and includes 117 full-page plates from 435 negatives. Many of the plates are extremely beautiful.

The characteristics of the people are admirably explained by their environment. They were preeminently an agricultural people, and the lack of domestic and wild animals prevented them from following the hunting and pastoral life. As a result, they settled in permanent villages usually along the coast. "Since there were no noxious insects, poisonous serpents or dangerous birds or beasts of prey, there was no occasion for the alertness and constant fear that so frequently makes life in a tropical country a never-ending strain if not an actual burden." An interesting paragraph on the medicine of the Hawaiians indicates a very considerable degree of medical and surgical skill. It is interesting to note further that boxing was perhaps their national game, and was regulated by certain rules, umpires being appointed, and the victor defending the ring against all comers.

What one notes all through the book is an extraordinary condition of the fauna and their place. Some of these changes have been due to the struggle for existence alone; others have occurred directly through the agency of man. As an example of this last, the sandalwood trade, beginning about 1792, resulted in the practical extermination of that valuable tree. As early as 1831 the trade was on the decline, and by 1856 the wood had become very scarce. Many trees and plants purposefully introduced have thrived in an extraordinary way, some of them in fact becoming important pests. The mesquite of the southwestern United States and Mexico, straggly, unimposing, although very useful, shrub-like tree that it is, becomes in Hawaii a rather imposing feature of the landscape; glorious specimens grow in some gardens of the city of Honolulu, and the large pods form one of the most important stock foods. On the other hand, the lantana weed, introduced for ornament, speedily became so abundant as to ruin the land over large stretches of the country, driving out every other plant. Inspired by their success in introducing beneficial insects to prey upon injurious insects, the Sugar Planters Association imported certain plant-feeding insects to kill off the lantana. This experiment, although very dangerous and never to be advised, was in this case apparently very successful, and the lantana, although still abundant, is no longer a serious pest.

It is interesting to note that there are no land snakes in Hawaii.

An interesting section deals with the whaling industry, since the Hawaiian Islands were in the center of this trade for many years, the industry reaching its height in 1852, thousands of native Hawaiians being employed as whalers.

The consideration of the birds of the islands is very full, although to the casual visitor there seem to be practically no birds. Although there are 125 or more species enumerated, not more than half a dozen can be seen

in the city of Honolulu, and all of these have been introduced. In glancing through the bird section, I note on page 326 the heading "The Legend of Maui and the Alae," and this reminds me to mention the fact that all through the book are scattered native legends which add greatly to its interest.

Reverting again to the extinction of native forms, the statement is made on page 333 that the island of Oahu can make the melancholy boast that it has a greater list of extinct birds, in proportion to the total number of species known from the island, than any other like area in the world.

One of the most attractive fields of natural history study in the islands is that of the fishes. Fish have always been one of the chief articles of animal food of the natives, and many strange and beautiful species abound in Hawaiian waters. The collection of native fishing apparatus in the Bishop Museum is a revelation to the modern fisherman. The natives caught fish in many most ingenious ways, and were expert in making a certain fish poison known as *holahola*. They were expert shark fishers in the olden times, and the use of human flesh as bait was in great vogue. The person to serve as bait was killed two or three days in advance of the anticipated fishing expedition. His flesh was then cut up, placed in a container and left exposed to the air to decompose. Interesting but grewsome! In walking through the markets of Honolulu to-day, the visitor from the States is able to recognize practically none of the fishes exposed. The fish fauna of Hawaii is isolated from that of other lands, although most of the common families of sea fish have local representatives, some of them excelling in flavor the species which exist elsewhere. One is greatly attracted by the "butterfly fish" on account of their bright colors.

The chapters on native and introduced insects are very interesting; and of course every naturalist knows the tremendous interest attaching to the land and fresh-water shells of the islands, and their weight in the discussion of evolutionary problems.

There seems to be at least one striking exception to the general rule which we have mentioned, of the easy adaptation of other forms of animal life to the Hawaiian climate, in the case of the eastern oyster, which has repeatedly been introduced, but which has never become acclimatized.

In the portion relating to sea life the book is especially interesting, and the story of the plants and animals from the coral reefs is fascinating.

Scientific men have been criticized frequently in the columns of SCIENCE for bad writing. The criticism can not hold for the author of this book, since it is written in a style which even the professor of English at Harvard would, I think, like to claim for his own. The writer of this note can not improve upon a sentence which has been used by Professor Vaughn MacCaughey in writing of this "Natural History of Hawaii": "It is a great guide book to the life of the tropical Pacific; it is encyclopedic in its wealth and precision of detail, and philosophic in its breadth of treatment."

L. O. HOWARD

Exercise in Education and Medicine. By R. TAIT MCKENZIE, B.A., M.D. Second Edition. W. B. Saunders Company. 1915.

Muscular exercise has played an important part in man's history whether considered from the standpoint of his health, growth and physical development, or his achievements and progress in civilization. As a branch of science, the application of exercise in education and medicine is in its infancy. The extravagant claims of dabblers and charlatans have done much to confuse the real issues and to retard progress.

Dr. McKenzie has made a valuable contribution to the subject by bringing together in this volume all the available material representing the present status of our knowledge concerning the application of muscular exercise in education and medicine. Since the appearance of the first edition four years ago, this book has been the chief reference work on the subject of exercise. The second edition has been completely revised and enlarged to include all the new material which represents the considerable progress made in the subject during the past four years.

The first chapter contains splendid definitions and a new classification of exercises of speed, effort and endurance. Chapters two to six are devoted to physiology of exercise; they contain the results of laboratory and clinical findings on the behavior of the muscles, heart, lungs, the organs of nutrition and excretion, and the nervous system during and after different forms of exercise; also, modifications produced by differences in age, sex and occupation.

The two chapters devoted to the effects of violent exercise on the heart are of particular interest at this time when the subject is the cause of widespread discussion by physicians, and educators, and giving much concern to the parents of boys and young men interested in athletics. After reviewing the literature on the subject and citing a number of cases from his own wide experience, Dr. McKenzie arrives at the following conclusion: "After the most severe strain one can seldom find any measurable injury in a week's time in a heart originally sound if the athlete has not passed thirty. It is in those unprepared for violent exercise, and especially when approaching middle life, that the danger of heart strain is most imminent."

A classification of athletic and gymnastic exercises and games on the basis of the regions of the body used; the demand on nerve control; the influence on pulse, blood pressure, and respiration; the physical characteristics cultivated; and the best age for practise should prove of great value to the individual and the practitioner in solving the problem of exercise for the sedentary man.

The remaining eleven chapters in Part I. treat in detail of the various systems of physical education in different countries, physical education and athletics in schools, colleges, municipal and philanthropic institutions, and the special methods applied to the training of the blind, deaf mute, and mental and moral defectives.

In Part II., the first three chapters treat of the application of exercise, massage, vibration, and passive exercise to pathological conditions. The remaining thirteen chapters deal with the treatment by exercise of flat-foot, club-foot, round back, stooped and uneven shoulders, scoliosis, abdominal weakness and hernia, visceroptosis and constipation, diseases of the respiratory and circulatory organs, obesity, nerve pain and exhaustion, tic, stammering, chorea, infantile paralysis and locomotor ataxia.

The author has succeeded admirably in presenting clearly the methods of diagnosis and treatment of the various abnormal conditions which may be improved or corrected by exercise, manipulation and massage. The critical discussion of the various methods advocated for the treatment of hernia, scoliosis, diseases of the circulatory and respiratory organs, and obesity, is particularly valuable because of the author's long and successful experience in the treatment of these conditions.

A large number of diagrams, line drawings and photographs illustrating physical defects, exercises and equipment add materially to the value of the book. This book fairly represents the present status of physical education and mechano-therapy; its use as a guide and reference work by educators, teachers, physicians and other scientists interested in the physical development and improvement of man should aid materially in placing exercise on a scientific basis.

George L. Meylan
Columbia University

Electrical Engineering. By Charles Proteus Steinmetz. Fourth edition. Entirely revised and reset. 368 pp., 194 illustrations. McGraw-Hill Book Co.

Since the appearance in 1901 of Steinmetz's "Theoretical Elements of Electrical Engineering" the art of electrical engineering has progressed so rapidly that four editions of the book have been necessary to keep it up to date. The present edition is not merely a reprint from former ones but has been thoroughly revised and rewritten. Some matter which appeared in former editions has been withdrawn and new matter has been added with the idea of preserving the unity of the book and at the same time making it representative of theory and practise as it exists to-day.

The text is divided into two parts, the first

on general theory and second on the application of this theory to particular types of apparatus. In the part on general theory we note the author using the crank diagram for vector represention of alternating quantities. This departure from his previous custom (use of the polar diagram) is not due to the conviction that the crank diagram is superior to the polar (in fact the author still thinks the polar diagram preferable) but the crank diagram is used to make the text conform with the recommendations of the Turin International Electrical Congress. This change in Steinmetz's notation will undoubtedly be appreciated by engineering students who, in so far as the writer knows, never were able to see the superiority of the polar diagram and who were always somewhat confused in reconciling the almost universally used crank diagram with Steinmetz's pet, the polar diagram.

The second part of the text on Special Apparatus is opened with a brief analysis of the scheme of classification used in presenting the various machines. While the author's classification may upset some of our present notions, the sense of it is at once apparent and it will surely come into favor in the future. The electrical machines discussed fall into one or the other of five broad classes, each class embracing all machines operating on a given principle, whether motor or generator. These classes are: Synchronous machines, direct current commutating machines, synchronous converters, alternating current transformers and induction machines.

Many readers of electrical literature have all of Steinmetz's books; certainly every one should have at least this elementary text on alternating current circuits and machines.

J. H. M.

Electrical Engineering. By T. C. BAILLIE. Vol. I. Cambridge, University Press: G. P. Putnam's Sons. Pp. 236, 131 illustrations.

This text, dealing in an elementary fashion with electric circuits, machines and measurements, is intended as the introductory volume of a series of electrical texts being published in the Cambridge Technical Series.

On reading the book nothing new is found, either in subject-matter or method of presentation. There are several other books to be had which cover the same ground in practically the same way.

The title of the book is apt to mislead one regarding its contents; it might more suitably be called an introduction to the subject of electrical engineering. The work covered in the text is ordinarily given in a technical school by the department of physics, as will be evident from a brief review of the contents. The chapters are entitled: Currents of Electricity, Magnetism, Current Measurement. Electromotive Force, Resistance Measurement, The Potentiometer, Batteries and Electric Light.

The subject-matter is logically presented and is fairly well illustrated by original diagrams and cuts of commercial apparatus. To the layman desiring a knowledge of some of the underlying principles of electrical engineering or to the student attacking the subject for the first time, the text would be very helpful.

J. H. M.

Electrical Instruments in Theory and Practise. By W. H. F. MURDOCH and W. A. OSCHWALD. The Macmillan Co. 366 pp., 164 illustrations. $2.75 net.

The writers of this excellent book evidently possess the two requisites for a successful text, mastery of the subject and the ability to express their ideas clearly. One is convinced on reading this book on meters that the authors have carefully considered the theory of the various instruments and have worked sufficiently with the meters themselves to grasp the errors which may occur and the ways in which they can best be eliminated. A very useful feature of the book consists of experimental data which is liberally given throughout to show how nearly the theory may be expected to agree with practise.

The first chapter gives a condensed history of the early attempts to measure electrical quantities; it serves well to give the student a proper appreciation of the modern metering devices.

The second chapter deals with damping and how it is obtained in meters. Permanent magnet instruments, iron core instruments, electrostatic meters, hot-wire meters and dynamometer meters each receive one chapter.

Watt-hour meters are discussed at some length; the errors in reading due to friction, short circuits, etc., are illustrated by experimental results. Magnetic testing apparatus is described and typical results given. The last chapter deals with the Wheatstone bridge, the Kelvin double bridge, and the potentiometer, for both continuous and alternating current circuits.

The writer knows of no book on electrical measuring instruments which is its equal in value to the advanced engineering student. A companion volume dealing with oscillographs, ondographs and other special devices is promised by the authors for the near future; it should receive a hearty welcome.

J. H. M.

SPECIAL ARTICLES

A NEW METHOD FOR THE GRAPHICAL SOLUTION OF ALGEBRAIC EQUATIONS

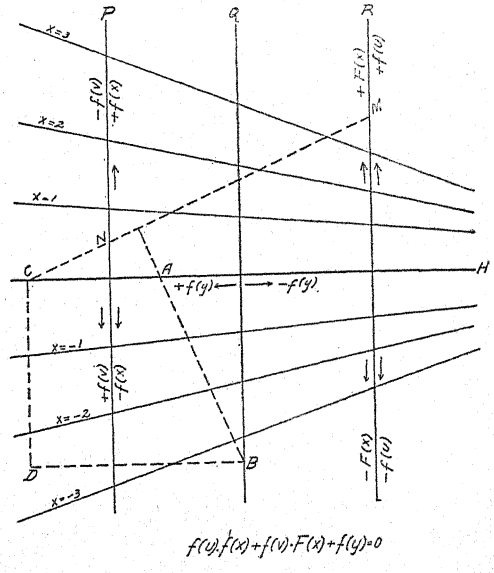
THE writer recently devised a graphical method for the solution of algebraic equations that seems to be of such general interest and importance as to be worthy of publication in this journal.

Let us consider first an equation of the type

$$f(u) \cdot f(x) + f(v) \cdot F(x) + f(y) = 0,$$

where $f(u)$, $f(v)$, $f(x)$ and $f(y)$ are the same or different functions of u, v, x and y. Construct a chart (shown in outline in Fig. 1) consisting of three vertical axes, P, Q and R, any convenient distance apart, intersected by a horizontal axis H. Along the right side of the axis P plot the calculated values of $f(x)$, positive values being laid off *upward* and negative values *downward* from the horizontal axis at a rate of A units per centimeter, A being so taken that the values of $f(x)$ likely to be met will fall within the limits of chart.

In a similar way lay off values of $F(x)$ along the left side of the axis R, positive values being measured off *upward* and negative values *downward* from the horizontal axis, at the rate of B units per centimeter, B being so taken that the values of $F(x)$ likely to be met will fall within the limits of the chart.



$f(y) \cdot f(x) + f(v) \cdot F(x) + f(y) = 0$

FIG. 1.

Along the horizontal axis lay off values of $f(y)$ at the rate of C units per centimeter, positive values of $f(y)$ being laid off to the *left* of the middle axis Q, and negative values of $f(y)$ to the *right* of that axis; C, being so taken that the values of $f(y)$ likely to be met will not lie too far to the right or to the left of the middle axis Q. Label the points thus located with the values of y used in calculating those of $f(y)$.

Values of $f(v)$ are to be laid off along the axis P in a way similar to that employed in laying off values of $f(x)$, positive values being measured *downward* and negative values *upward* from the horizontal axis H, at the rate of C/mB units per centimeter, where m is the perpendicular distance in centimeters between the outside axes P and R. Label the points thus located with the values of v to which they correspond.

In the same way, calculated values of $f(u)$ are to be laid off along the axis R, positive values being measured *upward*, and negative values *downward*, at the rate of C/mA units

per centimeter. Label the points thus located with corresponding values of u. To finish the construction of the chart, connect each value of $f(x)$ on the axis P with the corresponding value of $F(x)$ on the axis R by means of a straight line of indefinite length, which is labelled with the value of x to which it corresponds. In Fig. 1, several of such lines have been drawn and marked with the values $x=1$, $x=2$, etc.

Let it be supposed that the values of u, v and y in any particular example are known, and that the value of x is to be calculated. Locate the point M on the scale of $f(u)$ (axis R), marked with the given value of u. Locate the point N on the scale of $f(v)$ (axis P) marked with the given value of v. Connect M and N, and note the point of intersection, C, of this line or its prolongation with the horizontal axis H. Locate a point A on the scale of $f(y)$ corresponding to the given value of y. From A, draw a line perpendicular to the line MN, and note where its prolongation intercepts the middle axis at B. From B, draw a horizontal line, and from C a vertical line, intersecting at D. It will now be noted that D lies on a certain straight line, which is labelled with the value of x required; or it lies between two such lines, and the required value of x may be read by interpolation.

In practical work the chart shown in outline in Fig. 1 would be constructed on cross-section paper. We should need, in addition, a sheet of transparent paper or tracing cloth, having two perpendicular lines ruled on its surface. To solve an equation of the form we have been considering, simply move the transparent sheet back and forth over the chart until one of the two perpendicular lines appears to pass through the given value of u at M, and the given value of v at N, at the same time that the other perpendicular appears to pass through the point A corresponding to the given value of y. It will now be easy to note the apparent points of intersection of the perpendiculars with the vertical and horizontal axes at B and C respectively; and by following along the vertical and horizontal cross-sectioning from B and C we may locate the point D, and thus determine the required value of x, without actually drawing any construction lines on the chart itself.

As a special example of the use of such a chart, let us consider the calculation of the maximum temperature obtainable with natural gas burned without excess of air. The equation will be of the form $ax+bx^2=c$, where the value of the coefficients a, b and c depend on the composition of the gas, and the specific heat at various temperatures of the products of combustion. In a particular case, let the equation be

$$3.2044\ t + 0.00074057\ t^2 = 8{,}203 \text{ calories.}^1$$

The construction of the chart is simplified by the fact that the coefficients of t and t^2 to

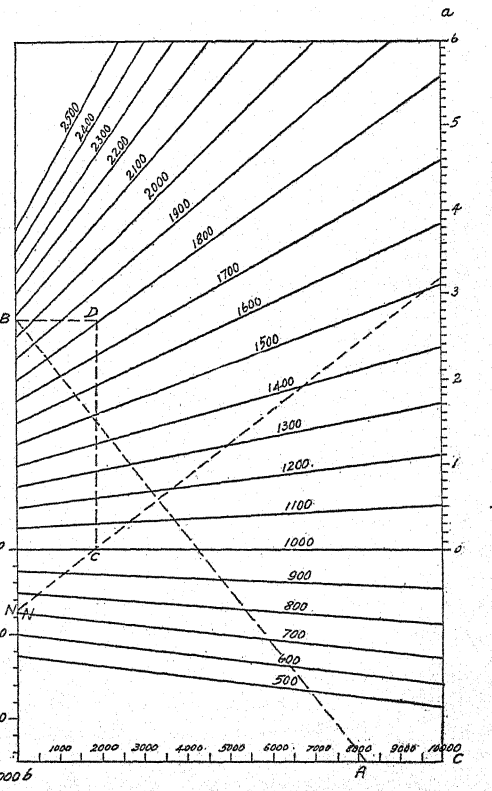


FIG. 2.

be considered will always be positive (Fig. 2). In this chart, the middle axis Q is moved to the left until it coincides with the left-hand

[1] Richard's "Metallurgical Calculations," Vol. I., p. 41.

axis, for the reason that the values of y (calories) to be considered will always be negative when transferred to the left-hand side of the equation, and will therefore lie to the right of Q. Since negative temperatures are not to be considered, the horizontal axis may be placed at the bottom of the chart.

In the construction of the chart let the vertical axes be taken 20 centimeters apart. Along the left-hand axis lay off values of t in an upward direction, at the rate of 100 units per centimeter ($A = 100$); in this way, the chart can be used for temperatures up to about 2500° C., if it be 30 centimeters high.

In a similar way, calculate the values of x^2 and lay them off in an upward direction along the right-hand axis, at the rate of 100,000 units per centimeter ($B = 100{,}000$). Since the maximum value of x to be considered is about 2,000, the graduations along the right-hand axis will extend about $2{,}000^2/100{,}000 = 40$ centimeters above the horizontal axis.

From left to right along the horizontal axis, lay down a scale for the various values of y, at the rate of 500 units per centimeter ($C = 500$). In this way, the maximum value of y (about 10,000) will lie about 20 centimeters from the left-hand end of the horizontal scale.

Along the left-hand axis, in a *downward* direction from a second horizontal axis (located at any convenient distance above the bottom of the chart), lay down a scale of coefficients of t^2, at the rate of

$$\frac{C}{mB} = \frac{500}{20 \times 100{,}000} = 0.00025 \text{ units per centimeter.}$$

Along the right-hand axis, lay off in an upward direction a scale of coefficients of t, at the rate of

$$\frac{C}{mA} = \frac{500}{20 \times 100} = 0.25 \text{ units per centimeter.}$$

To solve the particular quadratic equation given above, lay a transparent sheet bearing two perpendicular lines over the chart, so that the value of a (3.20), at M, the value of b (0.00074), at N, and the value of c (8203), at A, are crossed by the perpendicular lines of the transparent sheet. Note the point of intersection with the left-hand vertical axis at B, and with the auxiliary horizontal axis at C. From B and C follow along the horizontal and vertical cross-sectioning (not shown in Fig. 2) to locate the point D, where the required value of x (1805°) is read directly from the chart.

In Fig. 3 we have a further illustration of the use of such a chart in the solution of the equation

$$a \log x + b \sqrt{x} = c.$$

There are two values of $\sqrt{x}$, a positive and a negative one, for each value of x or $\log x$. There are accordingly two lines to be drawn from each value of $\log x$ on the left axis to connect with the corresponding values of $\sqrt{x}$ on the right axis. One of the two sets of lines thus formed has been shown in the figure by dashes.

Solution of particular equation

$$72.5 \log x + 6.25 \sqrt{x} = 54$$

is shown in the chart, the point D representing the value of x required. It will be noticed that in this case there are three different sets of lines that cross the region in which D happens to fall. There are accordingly three real roots to the given equation, the values read from the chart being 3.8, 10.5 and 530.

It is apparent that the number of real roots to any equation of the general form $a \log x + b\sqrt{x} = c$ will depend upon the values of the coefficients a, b and c. In the region in which the point D is shown, there are always three real roots, one of these satisfying the equation if a positive value of $\sqrt{x}$ be taken; the other two if a negative value of $\sqrt{x}$ be taken. In the region of the chart in which the point B falls, there is but one real root of the equation. If negative values of the coefficient b are considered the chart may need to be extended to the left of the left-hand axis; there will be two real roots in this region. If negative values of the coefficient a are considered the chart may need to be extended to the right of the right-hand axis. The trend of the lines in the diagram indicates that in this region there will in general be but one real root of the equation when a is negative; but in certain special instances, as for example,

when a is negative and c is very large, we may have two real roots; and there are other portions of the field where three real roots occur.

A use of the diagram, apart from the solving of equations, is thus to indicate the number of real roots that exist in the case of particular values of a, b and c. It is apparent that the chart will also indicate the effect of changes in the magnitude of the coefficients a, b and c on the absolute value or sign of x; and the reader will perceive that transcendental equations beyond the range of ordinary algebraic methods can be solved by this means.

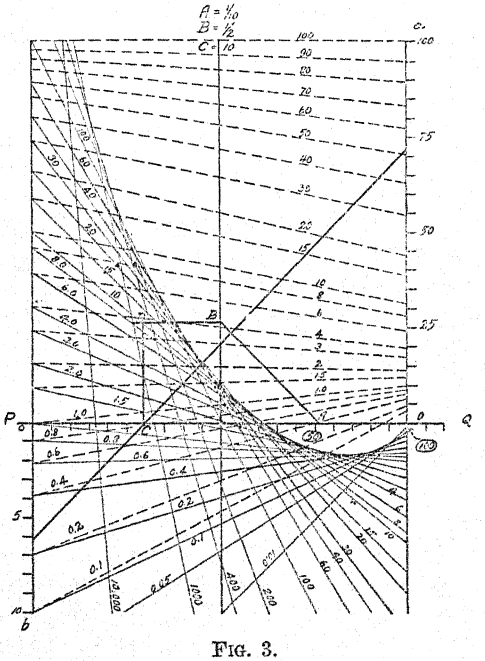


FIG. 3.

A further use for a chart of this kind is to suggest a proper empirical equation for the representation of experimental results. Thus, if the data collected in a series of experiments are believed to be expressible by an equation of the form $y = ax + bx^2$, the chart given in Fig. 2 may be used to determine the proper value of the coefficients a and b. The details of this procedure hardly require explanation; and other diagrams have already been published that constitute a graphical substitute for the method of least squares.

Returning now to the general case, it is evident that if $F(x) = 0$, we have

$$f(u) \cdot f(x) = f(y);$$

in this case the scale for $F(x)$ shrinks to a point at zero, through which all the lines representing different values of x must pass.

If $f(x)$ and $F(x)$ are constants the general equation takes the form

$$af(u) + bf(v) = f(y).$$

This may be charted as the so-called "alinement chart," well known to students of graphical mathematics.[2]

If $F(x)$ is replaced by $f(z)$ in the general equation we have five variables to consider. In this case $f(z)$ is plotted along the right-hand axis, the series of lines marked with the different values of x being omitted from the chart when the latter is first constructed. To use such a modified chart locate the point D in the usual way, then pass a straight line through D and that point on the right axis marked with the given value of z. The point of intersection of this line or its prolongation with the left axis gives the required value of x.

If two equations be given in which the values of x and z are to be determined, we locate two points D and D' in the usual way from the given values of u, v and y. Draw a straight line passing through D and D'. Its intersections with the left and right axes will give the values of x and z which simultaneously satisfy the equations. A set of three simultaneous equations of the general form

$$f(u) \cdot f(x) + f(v) \cdot f(z) + f(y) = 0$$

may be solved by an extension of this method.

It will be noticed that in the case last considered we are treating five variables, instead of the three that are included in the ordinary alinement chart. It was, indeed, by an extension of the principles of the alinement chart that the method presented in this paper was devised.

Exponential equations of all sorts may be handled by this method. Thus

[2] See, for example, Peddle, "The Construction of Graphical Charts," New York, McGraw-Hill Book Co.

$$x^u \cdot y^v = z$$

can be put in the logarithmic form

$$u \log x + v \log y = \log z,$$

and charted immediately.

It is even possible to combine two or more charts of the general type we have considered, enabling us to solve equations containing four or more terms. The method is thus almost one capable of handling algebraic equations in general; but further development of the subject would be out of place here.

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THE COORDINATION OF CHROMATOPHORES BY HORMONES[1]

The melanophores of the horned toad, *Phrynosoma cornutum* Harlan, become contracted during states of nervous excitement. All attempts to prevent this reaction locally by cutting various nerves have failed. It is thus suggested that the melanophores may be coordinated, in part, by a hormone produced during nervous excitation and carried to all parts of the skin by the circulation.

The skin of one leg may be isolated from the general circulation, without blocking its nerve supply, by tying a ligature snugly about the leg. When this is done the melanophores of the isolated leg remain expanded after the animal is thrown into a state of nervous excitement. The leg appears much darker than its mate. Upon removing the ligature the melanophores contract and the leg becomes pale. The effect is not due to a shortage of oxygen or the accumulation of metabolic products in the leg, for such effects do not influence the melanophores of a ligatured leg until much later and then they produce a *contraction* of the pigment cells. If blood drawn from a horned toad which is in a state of nervous excitement is injected into one of the subcutaneous lymph-spaces of a second animal, the skin above the lymph-space will become very much paler than that of the rest of the body. The injection of blood from a horned toad which has not been thrown into a state of nervous excitement does not have this effect. During states of nervous excitement the blood contains a substance which causes the pigment cells to contract.

What is this substance and where is it produced? The conception of a hormone coordinating melanophore activity is not altogether novel, for Fuchs (1914, pp. 1546–1547, 1651–1652) has attempted to explain the behavior of pigment cells in amphibian larvæ and reptiles by assuming that substances, perhaps internal secretions, which contract the melanophores, are produced in the body under the regulation of the pineal organ. Laurens (1916) has recently shown this hypothesis to be inapplicable to the phenomena observed by him in *Amblystoma punctatum*. That the pineal organ is not concerned, primarily at least, in the reaction in the horned toad is proved by the fact that removal of the entire brain anterior to the cerebellum does not prevent the melanophores from contracting during states of nervous excitation.

The studies of Cannon and his collaborators upon the physiology of the major emotions present a more promising clue to the nature of this hormone. Cannon and de la Paz (1911) have shown that during states of emotional excitement the adrenal glands are activated to such an extent that an increase in the adrenin content of the blood from the adrenal vein may be detected. Spaeth (1916) has amassed a formidable array of facts to prove that the melanophore is "a disguised type of smooth muscle cell." If Spaeth's contention be accepted, it would appear most probable that the melanophores should be controlled by adrenin, which occupies a particularly significant position in the physiology of smooth muscle (compare Elliott, 1905).

Adrenin has been shown to produce a contraction of the melanophores of the frog (Lieben, 1906) and of *Fundulus* (Spaeth, 1916). Very minute quantities have this effect upon the melanophores of the horned toad. Removal of the adrenal glands does not prevent

[1] Contributions from the Zoological Laboratory of the Museum of Comparative Zoology at Harvard College, No. 273.

the reaction which follows nervous excitement. This fact, however, merely indicates that there are other mechanisms capable of bringing about the reaction. By stimulating the adrenal glands electrically the melanophores of the entire skin may be contracted. If one leg is ligatured during this procedure, it will remain much darker than its mate; if the ligature be removed several minutes after stimulation has been discontinued, the leg will quickly become as pale as the rest of the body. If the gland be isolated from the general circulation by a ligature, no contraction of the melanophores will follow the stimulation of its surface.

From the foregoing it is clear that the melanophores of the horned toad are coordinated, in part, through the action of a hormone. There is some circumstantial evidence that this hormone is adrenin. Experiments are in progress designed to give more direct evidence concerning the latter point.

ALFRED C. REDFIELD

REFERENCES

CANNON, W. B., AND DE LA PAZ, D. 1911. Emotional Stimulation of Adrenal Secretion. *Am. Jour. Physiol.*, Vol. 28, pp. 64–70.

ELLIOTT, T. R. 1905. The Action of Adrenalin. *Jour. of Physiol.*, Vol. 32, pp. 401–467.

FUCHS, R. F. 1914. Der Farbenwechsel und die chromatische Hautfunktion der Tiere. Handbuch der vergleich. Physiol. herausgegeben von Hans Winterstein. Bd. 3, Hälfte 1, Teil 2, pp. 1,189–1,656.

LAURENS, H. 1916. The Reactions of the Melanophores of *Amblystoma* larva—the Supposed Influence of the Pineal Organ. *Jour. Exp. Zool.*, Vol. 20, pp. 237–261.

LIEBEN, S. 1906. Ueber die Wirkung von Extrakten chromaffinen Gewebes (Adrenalin) auf die Pigmentzellen. *Centralbl. f. Physiol.*, Bd. 20, pp. 108–117.

SPAETH, R. A. 1916. Evidence Proving the Melanophore to be a Disguised Type of Smooth Muscle Cell. *Jour. Exp. Zool.*, Vol. 20, pp. 193–215.

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

ON March 3, Dr. Caroline Rumbold, University of Pennsylvania, spoke before the American Philosophical Society of Philadelphia on the "Pathological Anatomy of Injected Chestnut Trees."

While working on tree injection in connection with the chestnut-tree blight, about 50 different substances: hydrocarbons, alkali metals and metals were injected in solutions of varying dilution into the trunks of chestnut trees. So far, an examination of the trunks and branches of the trees shows that the reaction of the tree to the injections was alike in kind though not in intensity. This reaction varied with the distance from the point of injection. The affected region extended up and down the trunk from the point of injection in a line, whose width usually was but little more than the injection hole. As the distance from this point increased the tissues appeared more normal and the area of disturbance decreased. Occasionally all stages of reaction to an injection could be seen in a tree: death—at the point of injection—retarded growth, stimulated growth and no reaction.

The regions that showed response were the cambium and the phlœm. The cambium as such ceases growth and is wholly converted into wood-tissue. Small isolated groups of xylem cells develop on the outside of the rows of normal bast-fiber, through proliferation of the already formed phlœm cells. Large and very numerous stone-cells appear in the phlœm, which increase in number until rows of them are formed. An increased number of calcium oxylate crystals form. The isolated groups of xylem, developed in above-mentioned manner in the phlœm, grow in area and coalesce. In this conversion the cells of the phlœm take part with the exception of the bast-fibers and the stone-cells. They are frequently found embedded in xylem. This conversion proceeds irregularly, leaving areas of phlœm surrounded by xylem, or groups of cells of an undecided appearance, apparently partly phlœm, partly xylem. No specimens have been found in which all the phlœm cells in the injected region of the bark had been entirely converted into xylem.

The conversion of the cells of the phlœm into xylem cells is not unknown, but it is believed that this is the first instance in which by injected chemicals this phenomenon has been produced and it may prove a help in the future histological study of the cells of the phlœm.

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 552d regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, March 11, 1916, called to order by President Hay at 8 P.M., with 28 persons present.

On recommendation of the council the following persons were elected to active membership: Dr. Molyneux L. Turner, R. T. Jackson, Biological Survey; H. L. Viereck, Biological Survey.

Under the heading Brief Notes and Exhibition of Specimens, Dr. Shufeldt exhibited lantern slide views of some of the aquatic and terrestrial vertebrates of the District of Columbia and Vicinity.

Under the same heading Mr. Wm. Palmer made remarks on and exhibited the bones of a hitherto unknown cetacean lately collected by him at Chesapeake Beach, Maryland.

The first paper of the regular program was by M. W. Lyon, Jr.: "Hemolysis and Complement Fixation." Dr. Lyon outlined the steps in the discovery of hemolysis by normal and immune serums from the early observation following transfusion by Landois in 1875, through Pfeiffer's phenomenon of bacteriolysis in 1889, Bordet's discovery of complement in 1899, Bordet and Gengou's discovery of complement fixation in 1901, to the practical application of the latter phenomenon as utilized by Wassermann in 1905 and by later workers in the diagnosis of syphilis, glanders, Malta fever, dourine, tuberculosis, infectious abortion, etc. The graphic conceptions of amboceptor, complement, antigen, and fixation as understood by Ehrlich, and as understood by Bordet, were illustrated by movable models. The action of hemolytic amboceptors and complement on blood cells of the ox and of the sheep was demonstrated by test-tube mixtures, and some positive and negative results in complement fixation were exhibited.

The last paper of the regular program was by D. L. Van Dine, "A Study of Malarial Mosquitoes in their Relation to Agriculture." Mr. Van Dine said: The Bureau of Entomology is making a study of the relation of malaria to agriculture and of the malaria-bearing mosquitoes, on a plantation in the lower Mississippi valley where typical conditions as regards malaria and plantation operations occur.

The object is to devise measures for prevention of malaria which will apply practically to farming conditions. Lines of work include determination of manner in which malaria operates in reducing farm profits, of the relative efficiency of *Anopheles* to act as transmitting agent and their distribution, of behavior of each species under known conditions of environment, and consideration of preventative measures which involve control of mosquito host.

Solution centers around prevention of malaria among tenants since it has been shown that the direct loss to planters occurs through lost time and reduced efficiency in labor. Detailed study was made of tenants, their relations to plantation, their habits and prevalence of malaria among them; the conclusion is that it will be more practical to control the mosquito than the human host.

One measure of prevention is favorable location of tenants' houses, demanding information on habits of flight, food and breeding. Where drainage is impracticable, surface water must be rendered unsuitable for *Anopheles* development. Food requirements and natural checks to larval development are being studied, the Bureau of Fisheries cooperating in a study of the relation of fish to mosquito development.

Anopheles quadrimaculatus, A. punctipennis and *A. crucians* were the species studied. *A. quadrimaculatus* is the common house-frequenting species of that region, *A. crucians* occurs in very limited numbers, and *A. punctipennis* is more restricted in its house habits but is common in nature. The work thus far has dealt almost entirely with *A. quadrimaculatus,* but following the demonstration of tertian and estivo-autumnal malaria in *A. punctipennis* by King in cooperation with Bass it will be expanded to include this species.

The study includes the habits of mosquitoes under low temperature conditions; also resistance of malaria organisms to low temperatures in body of mosquito host.

Mr. Van Dine's paper was illustrated with lantern slide views of the various conditions on the plantation. Messrs. Wm. Palmer, Doolittle and Knab took part in the discussion.

M. W. Lyon, Jr.,
Recording Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The 111th regular meeting of the Botanical Society of Washington was held in the Crystal Dining Room of the New Ebbitt Hotel, Washington, D. C., Wednesday evening, March 8, 1916. Eighty-two members and one hundred and seventeen guests were present. Professor A. S. Hitchcock presided. Dr. Rodney H. True, as retiring president, delivered an address to the society, entitled "Thomas Jefferson in Relation to Botany." This paper will be published in full in *The Scientific Monthly.* A dinner preceded the address and after it there was dancing.

W. E. Safford,
Corresponding Secretary

SCIENCE

FRIDAY, APRIL 28, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

MATHEMATICS IN NINETEENTH CENTURY SCIENCE[1]

THE treasures of one age are the rubbish of the next age. Ideas, like things material, are mostly transient. The present possesses but little of that which the past, with infinite labor, has acquired. Our estimate of values changes from century to century, and often with reason: what was once useful is found under later conditions to be wasteful, and new knowledge piles old machinery upon the scrap-heap.

Considered in this light, the science of even one hundred years ago looks antiquated to a schoolboy of to-day. But what of the exceptions? Not all knowledge is novel, and there are indispensable truths and fundamental principles that were discovered thousands of years ago. Most of our exact science is, however, new since the time of Galileo, Bacon and Newton; and it is probably not far from the truth to say that three fourths of the knowledge at present constituting exact science was discovered in the course of the nineteenth century.

Every generation must either advance, or lose much of what it has inherited; only as it is used for finding new knowledge is the value of the old science understood. I speak to-night to a group of younger students of science, into whose hands are committed from the past whatever they can use of accumulated knowledge; and who have announced, by the badge of Sigma Xi, their devotion to the highest ideal in science, that of increasing its definite content

[1] Address before the Syracuse Chapter of the Sigma Xi, March 15, 1915.

and improving its applications for the welfare of all men.

Every man must do what he can—hence comes specialization. Mathematics is and has been a useful kind of work, of value both immediate and prospective. It is of that I am to speak here briefly. On its utility I need touch but lightly, mentioning a few of the most obvious contributions to other branches of science; then I must point out more at length certain particular mathematical theories and bodies of reasoned abstract knowledge developed in the past hundred years.

These latter take their chance of survival along with the poetry, the art, the philosophy of their time—and indeed with much of what is now received as natural science. If it survives, it will be because you, and others like you who are to become intellectual leaders in the near future, find in these fields tasks which seem to you worth the doing; things begun which you would gladly finish, errors which must be cleared away to make room for truth; ideas in germ or questions vaguely hinted at, which can be worthily developed by your arduous labor.

First, then, let us recall some of those mathematicians whose labors have enriched other natural sciences since the time of Lagrange and Laplace. Four physical problems of major importance have demanded the devotion of mathematicians of the first rank, and have given occasion for the elaboration of theories now generally accepted. These are the problems of the transmission of light, of electrical and magnetic effects at a distance, of the relation between heat and other forms of energy in the world of force, and the historical question concerning the origin and growth of the earth on whose surface we live.

Not that the statement of a physical theory requires a mathematical mind; indeed the observatory and the laboratory are far more likely to be the birthplace of theories than the computing room or the logician's study. But whoever formulates a physical theory with precise terms, definitions and laws, and tests it for consistency of its parts and agreement with a wide range of facts—he is a mathematician; and if the complexity of his problem drives him to invent new concepts or new short-cuts in argument, he is a creative mathematician.

Such was Fresnel, who in 1817–19 analyzed and pushed to precise formulation the theory of wave-motion in the luminiferous ether. The hypothesis of an ether was not unknown at that time, and in acoustics the undulation theory was well established. Authorities, however, seemed overwhelmingly in favor of the emission theory of light—Descartes, Newton, Brewster, Laplace and Poisson. It required the resolute and unperturbed mind of a true investigator to give due attention to the hypothesis, then far from orthodox, of an all-pervading ether, and to build up a complete theory of the phenomena of diffraction until it brought him to a crucial experiment, which even his opponents admitted to be decisive. When its implications were completely analyzed and their consequences demonstrated, doubt and prejudice gave way to clearness and certainty. The controversy was practically closed when in 1820 Fresnel received the medal of the Paris Academy for his essay on "The Diffraction of Light." And this general indorsement of the ether hypothesis was most essential for the next pressing problem, that of the transmission of electrical effects.

The effect of a small closed current of electricity upon a magnetized particle in its field is like that of a magnet, feeble or strong, standing at right angles with the plane of the current. One closed current attracts or repels another, just as one

magnet acts upon another; and a current closed or broken in one circuit occasions a current in another closed circuit. Experimental studies of these phenomena by Faraday and Weber revealed quantitative laws, but seemed to show instantaneous effects—forces acting at a distance with no delay in time. The marvellous intuition of Faraday, not himself an analyst, but certainly a profound inventor of geometric motions, created an ideal structure of tubes of force, with something flowing through them under hydrodynamical laws. This bold concept served as basis for the calculations of three mathematical minds that took up his great problem. Sir William Thomson, later known as Lord Kelvin, Helmholtz and James Clerk-Maxwell, each in his own way set forth, in precise notations, equations describing the amount and direction of the transmitted forces. Thomson and Helmholtz ventured hypotheses upon the nature of the transmitting medium and its motions, culminating in those vortex-rings and vortex-sheets which were studied eagerly two decades ago.

A closed vortex-filament in a perfect fluid was shown to be indestructible, and ardent was the hope that properties and differences of vortices would be found analogous to those of the indestructible atoms of chemistry. But the third, Maxwell, penetrated in another direction, and showed what ought to be the rate of transmission of electrical impulses or waves, through an ether such as carries waves of light. The result, that electrical effects travel with the speed of light waves, shows logic outrunning even imagination. Hertz, almost the equal of these three as a mathematician, still greater as an experimenter, actually sent out and collected again such waves, a hundred thousand times longer than waves of light, reflecting and refracting them like light, and so confirmed the speculative conclusions of Clerk-Maxwell. In this exciting race to show the analogy, resemblance, or even identity of things apparently unlike, the study of vortex-rings was suffered to lapse. Or was it because physicists perceived that atoms were not so simple as had been supposed; that it would require, for the explanation of a single atom, more than one ring, however intricately self-involved? At any rate, there remains that one fragment of theory to be revalued and completed by some genius of a future generation.

Certain passages in the preface of Maxwell's "Electricity and Magnetism" show so clearly the relation of mathematical to experimental science that I can not refrain from extracting them verbatim; but first I will quote a general remark from Samuel Beidler upon accuracy.

> The appreciation of the value of accuracy is a thing of modern date only—a thing which we owe mainly to the chemical and mechanical sciences, wherein the inestimable difference between precision and inaccuracy became most speedily apparent.

Maxwell's idea of the way in which deductive methods come to be applied to phenomena is compressed into these two passages. Observe that measurement is fundamental.

> I propose to describe the most important of these phenomena [electromagnetic], to show how they may be subjected to measurement and to trace the mathematical connections of the quantities measured. Having thus obtained the data for a mathematical theory of electromagnetism, and having shown how this theory may be applied to the calculation of phenomena, I shall endeavor to place in as clear a light as I can the relations between the mathematical form of this theory and that of the fundamental science of dynamics, etc.
>
> There are several treatises in which electrical and magnetic phenomena are described in a popular way. These, however, are not what is wanted by those who have been brought face to face with quantities to be measured, and whose minds do not rest satisfied with lecture-room experiments.

Though he insists that Faraday's methods were mathematical, merely expressed in symbols different from those usual among other mathematicians, yet the world knows that Faraday's labors could not have borne such abundant fruit, had there been no Maxwell to interpret and push to their limit his theories. By the combined labors of physicist and mathematician it was finally established that electro-magnetic action at a distance is due to disturbances of the same ether which conveys light-waves, and that this action occupies measurable time; that its velocity is indeed that of light itself, and that light-waves are of the same nature as those sent out from an electric current periodically interrupted. Compare this certainty with the state of doubt, at the beginning of the nineteenth century, upon the relative merits of the corpuscular theory and the undulation theory of light. Refined measurement and rigorous logic had indeed produced a visible effect!

In 1873 was published Maxwell's immortal treatise on "Electricity and Magnetism." In the same year appeared the first work of Josiah Willard Gibbs, then a young professor of mathematical physics in Yale College, on "Graphical Methods in the Thermodynamics of Fluids"; and only five years later his most important work, "On the Equilibrium of Heterogeneous Substances." By this time the great law of the conservation of energy was fully recognized, but its detailed implications were mostly still vague and imperfect. It was certain, however, that in each conversion of energy into other forms there was a degradation of a part: that not all the energy present could ever be utilized as mechanical force; some small percentage was always reserved in the form of heat, or electric potential, or chemical energy, or otherwise. Some vaguely understood quantity called entropy was in the field, so that the total of energy present was divided between entropy and free or available energy. Gibbs set himself the problem: Given all the masses and energies present, of every particular kind, in a physical event, to specify the amount of each kind that will be present when equilibrium is restored. In short, he wished to express as precisely measured quantities the facts implied in the conservation theory. As a corollary, he verifies the brilliant dictum of Clausius, that entropy is a continually increasing quantity.

There is evidence that Maxwell's work waited fifteen years for its full effect to be felt in the scientific world. Gibbs's researches and theories waited somewhat longer, but are now recognized quite generally (I quote his biographer) as being "among the greatest and most enduring monuments of the wonderful scientific activity of the nineteenth century." One may say in brief that Gibbs passed from known laws of physical and chemical action in infinitesimal regions, to reach the succession of transient conditions and to describe the limiting condition of equilibrium, toward which the total finite mass must tend—a maximum of entropy, a minimum of free energy. It is certainly plausible to say that as he dealt with infinite systems, varying from point to point as well as in time, he was forced to invent statistical methods and to rely upon the theory of probability. The most remarkable feature of his work was the fact, noted by his French and German translators and editors, that its theorems reached beyond truth as experimentally known, and served as guides for laboratory research. To paraphrase his biographer, the important and admirable thing in his work is not any new physical hypothesis, but the extraordinary mathematical power which deals simply and rigorously with relations of great apparent

complexity. It is not surprising therefore to find Gibbs almost equally distinguished in difficult fields of pure mathematics, the geometry of N dimensions and in vector algebra.

I have not yet mentioned astronomy, nor living scientists; but can not forbear to call your attention to the apparent decline and fall of the Laplacean theory of the earth's genesis from a nebula, its slow concentration and shrinkage. Two eminent scientists of the present day, Chamberlain and Moulton, have resolutely insisted upon precise formulation of hypotheses, have subjected them to calculation as exact as the case admits, and seem to have established the superior probability of their planetesimal hypothesis: that the major part at least of the earth's mass is the result of slow accretions from intercepted streams of meteorites. It may be that a new theory of nebular evolution must be constructed, starting from the spiral arrangement visible in so many of Hale's and Ritchie's photographs. Certainly there is a strong temptation for younger scientists to join in the working out of this great problem, now successfully past its initial stage.

Most scientists can and will become mathematicians when their special problems reach the stage where measurements are possible, and pure mathematicians should be eager to discuss concrete problems when they see the possibility of applying methods that they understand. But there is an independent territory of pure mathematics, a realm of the understanding and the reason. Its fields have been explored, subdued and cultivated by men of genius, men of strong imagination, men of patient diligence, and by adventurers, ever since the beginnings of history. If the triumphs of natural science loom larger before the eyes of the average man, it is on account of his intellectual position and the distortions of perspective. Has man yet included in his scientific knowledge such a part of the now knowable universe as would be represented by any finite fraction, however small? Is all that the whole race has known, compared with the secrets yet to be discovered, as considerable as the smallest twinkling star among the fiery millions of the galaxy? Are not all scientists, with Sir Isaac Newton, children wandering beside the sea and gathering the pebbles that please them? The intellectual booty gathered by pure mathematicians in the past century was relatively not less magnificent than the fragments of understanding secured by scientists of the concrete; nor is the one kind, in the last analysis, more purely intellectual than the other. All true science is rational, and belongs equally to the reason. I shall name but few of the nineteenth century discoveries in pure mathematics, and not, perhaps, the most important; for in the record of times so recent each will necessarily praise the things that he himself has most admired.

Geometry has made more numerous and more important advances than in the previous three centuries. Her devotees have been numbered by the hundreds. Read the appreciative chronicles of Professor Gino Loria in "Il passato ed il presente delle principali teorie geometriche," in which he sets forth a noteworthy thesis, first propounded by the great French geometrician, Chasles. This science, he declares, is the most attractive, because the humblest worker may hope by diligence not merely to survey the edifice, but to build it further. Genius is no longer indispensable to him who would add a stone to its walls. This exhortation is equally valid to-day; and for this reason a young mathematician may well devote some time to geometry, even if his ultimate dream leads elsewhere.

The earliest years of the century saw the

rise of a geometry freed from Euclid's postulate of parallels. The chains forged by habit and by authority were broken, and with ease when once they had dared the attempt, men found that the existence of one parallel to a line through a given point was not the only workable hypothesis: all other axioms and postulates of Euclid might stand, while instead of this one they substituted either *no parallel,* or *more than one.* Lobachewski, Bolyai, Saccheri, and probably the great Gauss, were leaders in this memorable emancipation. It was left for the later decades to reflect upon the reasons and to furnish illustrations of the various possible kinds of systems of points, lines and surfaces. Along with parallels, of course right angles, the measures of all angles and the measurement of distances were subjected to revision; and late in the century Cayley and Klein invented the theory of projective measurement of linear segments and of angles, to re-combine the divergent kinds of systems into one harmonious theory. It is easy to misunderstand. I do not mean to say that non-Euclidean geometries require substantiation or sanction from the older system of Euclid; or that the kind of space which they describe presupposes a Euclidean space within which it may exist. The question of the true nature of the space we live in is equally foreign to all pure geometries. But our common experience accords sufficiently with the description given by Euclid, and men will always, no doubt, find his axioms preferable. Hence it was and always will be advantageous for us to have as illustrations of non-Euclidean geometries pictures of definite portions of Euclidean space and of objects therein which fit the described relations of other systems in other kinds of space.

Fortunately for my present theme, and its secular limitation, the end of the century brought a full and satisfactory discussion of the fundamental postulates of geometry, by Hilbert of Göttingen. This gave us a model for the examination of not only the traditional Euclidean and the two traditional divergent non-Euclidean geometries, but also for the testing of any other proposed system of fundamental postulates. For the first time, the consistency and independence of sets of axioms were tried and proven. And this was a boon equally to teachers of all grades; for the redundancy of text-book definitions and axioms in geometry had become an intolerable incubus to teachers of critical classes, who yet had not the patience nor the time for finding the solution of their own difficulties. Kant lived and philosophized too early. Axioms must now be judged by their utility for the purpose intended. But whatever they have lost in sacrosanctity and authority, far more is gained in freedom and in power.

Chronologically it is false, but in the inevitable logic of events it is true, that projective geometry developed simultaneously with non-Euclidean. The latter clung to measures but looked at parallels differently, the former viewed distance as changeable and considered parallels as intersecting. Descriptive geometry, the body of rules and relations collected in orthogonal projection, parallel projection, and central projection, acted as a stimulus or challenge. Here were a set of observed phenomena, partly reasoned, ready for precise definition and logical arrangement. On the other hand were visible the beginnings of algebraic geometry, presenting general methods and highly general theorems, threatening to engulf and obliterate all pure geometry except the most elementary. Let any student of analytic geometry reflect on how few theorems from elementary geometry the whole analytic superstructure rests! No wonder that those who preferred things rather than

symbols seized the most obvious means for enlarging the scope and abbreviating the processes of their favorite science! Into the existing knowledge they brought order and system, circumstances of the time gave it rapid development, and a new branch of science came into being.

So projective geometry was cultivated. It was the avowed rival of algebraic geometry. The problems solved and new theories advanced by Monge, Poncelet and Steiner were matched by the genius of Plücker, Moebius, Cayley, Clifford, Cremona and Sylvester. The theorems of the one kind, resting on algebra, were perfectly general; those of the other, founded on intuition of real elements, were compelled to state exceptions. To escape this obstacle, Poncelet stated the postulate of continuity, a logical, almost magical bridge over the lacunæ. But in algebra, when real quantities failed, there were the imaginary quantities to fill the gap. What could pure geometry exhibit as justification or explanation of the continuity that she had postulated? It was a recluse professor in a provincial university, von Staudt, of Erlangen, who settled the matter once for all with a perfect analogy. As algebra defines imaginaries by real quadratic equations whose roots are not real, so, according to von Staudt, geometry defines two imaginary elements by two real pairs of elements. In certain relative positions these determine two real elements; otherwise they stand as a real representation of two imaginaries. This is genius: to define the required object by the very phenomenon which constitutes the demand. What is sauce for algebra is sauce for geometry, and the imaginary elements are since that time the secure possession of both.

What then were the conquests of algebraic geometry? The ancients had examined conics and conicoids, that is, circles, ellipses, spheres, ellipsoids, and those alluring surfaces, the paraboloids, all loci of the second order. Sir Isaac Newton had made a pioneer study of plane curves of the third order, a venture in which for more than a century only two had followed him, until Moebius and Pluecker, about 1835, resumed the attack. It would take many hours to name in most concise form the new features and new problems that arose from this study. Inflexional points, Steinerian correspondences, poloconics, harmonic polars, Cayleyan and Hessian covariant curves—these will serve to remind some of you of the multiple ramifications of inquiries that began on plane cubic curves. Others will recall the metrical properties of semicubical parabolas and cissoids. Of quartic curves, the next higher order, even more is to be said—or omitted; their 28 double tangents and 24 inflexional points and many seemingly elementary problems connected with them remain unfinished, as students in all lands can testify, among others not a few Americans who have given labor and time to them.

Progress is often along converging lines. While geometry advanced steadily in the algebraic direction, algebra was acquiring a new concept, that of a GROUP of operations. Any set of operations form a group, when two of them unite to form always a third in the same set; thus, uniform expansions and contractions of an object form a group, and in numbers all multiplications and divisions together form a group. Now a group of operations will change some things and leave others unchanged or invariant. In algebra, the group of linear substitutions was the first to attract attention, and between 1845 and 1865 the study of this group was the most conspicuous business of algebraists. Soon it was recognized that in geometry all projective transformations constitute a group, and that

this is precisely the same as the group of linear substitutions, if points in space are given in rectilinear coordinates. From this it was not a long stretch to the conjecture that the properties of objects unchanged by projection must be expressible in some way in terms of the invariants discovered by algebraists. To work out this thought demanded the ardor and mathematical ingenuity of a race of intellectual giants like Cayley and Sylvester, Aronhold in Berlin, Hermite, Clebsch and Brioschi. Through their toil a special calculus was developed, and some progress made toward answering the central question: What, under the projective group, are the different possible invariant properties of single algebraic loci, and what the chief invariant relations of two or more loci or systems of loci? Here then was established a definite standard, by which it could be judged whether geometry was a science, or only the ideal program of a science. The group of operations, the simplest objects to be considered, and the invariant relations of those objects under the group: these covered the content, at least of projective geometry.

Probably no climax of equal significance for pure mathematics has been reached since Newton and Leibnitz took the scattered fragments of a theory of limits and from them created the differential and integral calculus. It was in 1872 that Felix Klein published from the University of Erlangen a brief program, or formal address upon assuming a professorate. The title was: Comparative observations upon modern geometrical investigations, and its central thesis was in essence the formal definition, just now mentioned, of geometry. There are many sorts of geometry, but all are alike in this, that each studies its own peculiar group of transformations, and seeks to discover and classify the properties of objects which are invariant under all the transformations of its group. This was then verified by a survey of all kinds of geometry developed up to that epoch.

Of especial interest is of course our elementary geometry, the standard Euclidean. We know its objects; what is the GROUP that it studies? Klein answers: The absolute position in space may be changed, for that change no one can distinguish. An exchange of right for left, as in the space seen in a mirror, does not alter relations that we call geometric. Moreover all size is merely relative, hence uniform expansion or shrinkage in all directions is an operation of the group. Hence rigid motion including rotations, homogeneous expansions and reflections against a plane, those with their myriaform resultants constitute the group of ordinary geometry. I have mentioned the group of projective geometry; others are the geometry of circles and spheres, admitting to its group all operations of elementary geometry and in addition all reflections upon spherical mirrors; the two kinds of non-Euclidean geometry, the four-dimensional geometry of lines, inaugurated by Plücker, and the geometry of contact-transformations, defined and begun by Sophus Lie, of Norway. Many others can easily be noted and named, all fitting Klein's description in so far as they are developed, by any student of mechanics, hydrodynamics, optics or indeed any perfected theory in physics. As science tends to become deductive, and as geometry is the most complete type of a deductive science, and now since Klein's program elucidates the ideal or norm of geometry, so it may well arrest the attention and illuminate the procedure of every systematic scientific investigator.

It must have been this mode of conceiving the essence of geometry that was before his mind when Gino Loria, the historian of modern geometry, wrote the fol-

lowing passage in the epilogue of his famous book:

> The figures of geometry which once appeared rigid and motionless—as one might say, lifeless, acquired from the theory of transformations an unlooked for vitality, by virtue of which they were changed one into another, disclosing thus kinships before unknown and establishing relations which had been previously not even suspected.

This expresses well the esthetic feeling of a scientist who ponders upon the meaning of his work, and it contains a hint of the mystery of the fleeting fact and the truth which endures.

Within the century we see geometry coming to definite ideal statements of her foundations and her aspirations. Hilbert has described the one, Klein the other. No longer are we to see interminable debates concerning empirical warrant or intuitive warrant for the truths of this exalted science; though these debates may be profitable, they are not geometry. Mathematics begins when we are agreed upon premises. No longer is there to be the illusion of completeness, as if the problems could all be finished, their invariants determined and interpreted. The question for an investigator who considers a problem is now that of the miner who is prospecting for precious metals; he must ask himself: Have questions like this proved simple enough to be solved, and have the results proved interesting or useful? As for the range of choice, there are appallingly long lists of classes of geometries in the new "Encyklopädie der Mathematischen Wissenschaften." Some I have named: differential geometry is full of attractions; the study of twisted curves and of the systems of curves on surfaces is practically still in its beginnings, with vigorous workers calling for recruits; finite point-systems have claim to early consideration; manifolds in space of more than three dimensions will later assume increasing importance; recent procedures in analysis must some time be subjected to geometrical statement in the hope of simplification; and nothing could be imagined more exciting than the geometrical and kinematical speculations upon the configurations or constellations that the physicists call atoms and molecules.

My choice of topics has been apparently capricious, for there is matter of importance and intense interest in all directions. It is worth mentioning that no fewer than five living Americans have produced books on the theory of functions, or some great division of that subject. Elliptic functions and the vast subject of hyperelliptic and Abelian functions are temporarily less active, while differential equations, and their successors, integral equations, are in the forefront of progress. The theory of numbers in its modern form dates back only to 1800, and teems with marvels unforeseen. It is within fifty years that Lindemann succeeded in proving the number π transcendental—the ratio of circumference to diameter, and it was almost twenty years later that the base of Napierian logarithms, the number e, was put into the same category. The classification and discovery of transcendental numbers is still going on. Concerning the combinatory analysis with its store of theories yet incomplete, one does not need to bring news to Syracuse, nor coals to Newcastle. But I may mention the researches on point-sets, set in motion by Kantor at Halle, and refer you to the summary views and keen commentaries of Van Vleck, professor in the University of Wisconsin, in his recent address as retiring president of the American Mathematical Society.[2]

The close of the past century saw the extraordinary growth of scientific societies, and in particular of mathematical societies. Three I may instance, all less than thirty

[2] See SCIENCE, Vol. 39 (new series), pp. 113–124.

years old with active membership ranging from 600 to over 900, the American, the German, and the Italian in Palermo. Taken with other things, these are signs of a flourishing condition of scientific thought. Possibly the most striking proof of this, so far as mathematics is concerned, is found in the annual quantity of published research which more than doubled during the last thirty years of the century.

No one understands the group of transformations which we call the flight of time, yet it acts unceasingly upon all human possessions. Nor are its invariants known; nor yet can we determine what part of scientific energy is conserved and what part is entropy, or waste. It seems to us now that the few great lines of development that I have so briefly traced do show permanent tendencies of organized knowledge—that in these directions science will at least not retrograde while our civilization endures. Yet it is already evident that the last word has not been spoken in physics, and conceivably the time may come when the names of Helmholtz, Kirchoff, Maxwell and Hertz will be venerated as that of Archimedes now is—hardy pioneers indeed, but no longer in the vanguard. Let me make the trite remark, that the transformations of time work more slowly on the body of treasure that we call pure mathematics than they do upon the far greater and more rapidly growing pile of natural science. The reason is obvious; natural science deals with an infinite number of data, and can never apprehend them all; hence she makes hypotheses serve temporarily. Mathematics does the same, but perfects her products by the progressive exclusion of conflicting data; that is to say, by increasing precision of terms. The Pythagorean theorem concerning the sides of a right triangle will be true longer, in the very nature of things, than Sir George Darwin's magnificent theory of the tides. This which is from one point of view a reproach to pure mathematics, constitutes on the other hand one of its titles to immortality.

That the literature of our science is vast and complicated shows only how many are the things that men have wished to know. More numerous, with every advancing decade, are the questions pressing for solution. It will not be your lot, members of the Sigma Xi, to discover anything so simple, necessary and universally useful as the multiplication table, or the common theorems upon volumes and areas; but you may find something as useful to mankind as Napier's logarithms, which were new only three centuries ago; or some theory as beautiful and perfect as that of elliptic functions applied to plane cubic curves. You may contribute to the labor of other scholars something as helpful as the great "Encyclopaedie" of the mathematical sciences, now almost completed by the untiring labor and devotion of cooperating mathematicians in all lands, but chiefly by Germans. But in whatever large domain or narrow field you may elect to labor, I give you the cheering assurance that there are fruitful discoveries that can be made by every toiler; that to each one who has the *will to know*, will come those rare and golden moments when he shall shout in triumph, with the ancient truth-seeker Archimedes, *Eureka!*

Henry S. White

Vassar College

SEEING YOURSELF SING[1]

It is possible to make vibrations which produce a tone to the ear also produce a picture to the eye—a picture which reveals details of pitch faithfully and far more finely than the ear can hear, and which may, therefore, be

[1] A part of a paper read before the meeting of the National Music Teachers Association in Buffalo, New York, December, 1915.

employed for the objective measurement of pitch and as a guide in training to sing and play in pitch. The singer standing before an instrument sees in clear pictures every pitch movement of the voice as he is singing; he sees exactly how many vibrations per second the vocal organs are producing, and thereby can tell, at the very moment of singing a note, what error is involved, even down to the hundredth of a tone; he can practise before the instrument by the hour with the opportunity of seeing the error in every tone and controlling the voice and the ear by the eye at pleasure; he can study in detail the attack, the sustaining, and the release of a single note; the player of the violin, flute, cornet, or other instrument may treat his instrument in the same way; a person at a distance may connect "long distance" with the tonoscope and project his voice or instrument on this screen hundreds of miles away; a scientist or a musician may take a phonograph record of the tonal effects under observation and ship the cylinder to the laboratory, in which it may be reproduced upon the tonoscope; the student of primitive music can transcribe the phonograph record by this method; the scientist can undertake technical studies on pitch which involve exact measurements and instantaneous recording in actual singing; the student of public speaking can study the inflections of the voice objectively and train for mastery; the teacher of the deaf can place his pupil before the instrument and train him to speak with pleasing inflection of the voice by practising with the aid of the eye.

This array of claims may seem extravagant, but these and many other related achievements are made possible by the development of a ready and accurate method of registering pitch. The instrument which will do this is known as the *tonoscope,* and is now available for use in the studio, having been placed on the market in December, 1915.

THE TONOSCOPE

The tonoscope[2] shown in the accompanying illustration[3] works on the principle of moving pictures, technically known as stroboscopic vision. It converts the sound vibrations into pictures on the screen. The screen, which may be seen through the opening on the front, has eighteen thousand and ninety-five dots so placed

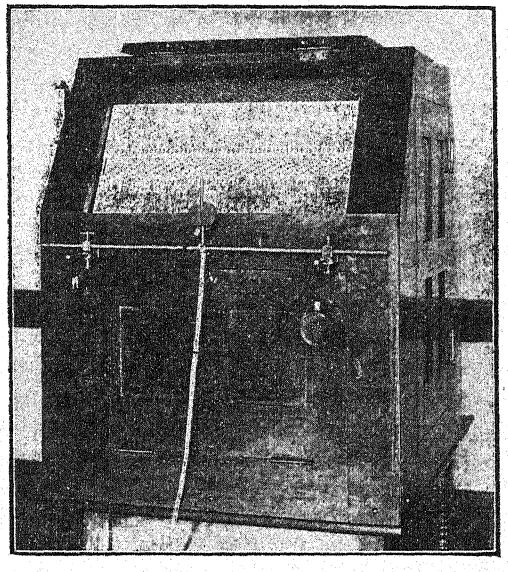

FIG. 1. The Tonoscope.

that, when acted upon by a sensitive light, they arrange themselves in characteristic figure for every possible pitch within the range of the human voice. Each figure points to a number on the screen which indicates the pitch. The dots are arranged into one hundred and ten rows; the first one has one hundred and ten dots, the next one, one hundred and eleven dots, and so on, each successive row having one more dot than the preceding one, up to the last, which has two hundred and nineteen. When the tone is sounded, the row which has the dot frequency that corresponds to the vibration frequency of the tone will stand still, while all

[2] A full account of this instrument by the present writer, and an article by Dr. Walter R. Miles reporting investigations made by means of it, are to be found in the Psychological Monograph No. 69, pp. 1–66, *Psychological Review,* Princeton, N. J.

[3] In this illustration the sensitive flame is energized through a microphone; but ordinarily, simple air transmission to the manometric flame through a speaking tube is used.

other dots move and tend to blur. The row which stands still, therefore, points to a number on the scale which designates the pitch of the tone. The screen contains a sufficient number of rows of dots to cover exactly one octave. Tones above or below this octave are read on this same screen by multiples.

To see the pitch of the tone, one has, therefore, only to see the number of the line that stands still. The tone may be sung or played under natural conditions. Indeed, one may register the tone from any distant point with which there are telephone connections.

The instrument is operated electrically and will run indefinitely without any care or disturbance. This makes the tonoscope a ready and continuously available instrument in the studio or the laboratory. The speed of the revolving screen is controlled by a tuning-fork with which it must keep step, being driven by a synchronous motor.

In other words, we have here an instrument which will transform the vibrations of voice or instrument to visual configurations on a scale that indicates the actual pitch of any note down to an accuracy of a fraction of a vibration—often less than a hundredth of a tone. Indeed, if we are dealing with a note as constant as that of a tuning-fork or a string, the pitch will be recorded accurately in tenths of a vibration, because fractions of vibrations may be read in terms of the number of dots that pass per second in the slowly moving line.

There are various graphic methods of recording pitch in use, but these are entirely too laborious and cumbersome for practical use. The tonoscope furnishes us the first ready and at the same time reliable and accurate means of registering directly the pitch of a tone as sung, spoken, or played with a musical instrument in such form that it can be operated with convenience and safety outside the technical laboratory.

The Significance of this Instrument for the Science of Tones

The psychology of music on the sensory side has been studied with fruitful success in recent years. But the motor side of the process—the psychology of tone-production and tone-control—is practically unworked and remains largely in the realm of mystery chiefly for the want of a measuring instrument. The introduction of a ready means of recording, analyzing and projecting sound vibrations before the eye therefore opens up a most wonderful field of research both in pure science and in the art of music.

Up to the present time there has been only one tonoscope available, that in the psychological laboratory of the University of Iowa. This has passed through several stages of improvement during the last fifteen years; and this single instrument in its various stages of development, in the hands of a small group of investigators, has been a valuable aid in the discovery of interesting facts in the psychology of music. The scope of the work which has thus been opened up by investigations already undertaken may be illustrated by the naming of the principal problems which have been investigated up to date, to wit: the comparison of men and women as to ability in singing of true pitch, under a large number of controlled conditions; relative accuracy of pitch within the tonal range, under various conditions; principles involved in the singing of large and small, natural intervals and more artificial intervals; the effect of the strength of the keynote upon the accuracy of reproduction; the effect of the volume of the voice upon the pitch; the variation of pitch with vowel quality or timber; the correlation of ability to sing in pitch with pitch discrimination, tonal memory, tonal imagery, sense of consonance, musical education, and other factors; the establishment of norms for the measurement of ability to sing in pitch; and the study of the effect of training the ear by the aid of the eye. Some of these are reported by Miles in the article referred to above, Psychological Monograph No. 69. The scope of this paper will permit the discussion of only one of these, and for this purpose, the last mentioned may be chosen.

Training the Ear by the Aid of the Eye

The practical use of the tonoscope in the

studio lies in the training of the ear and therefore, indirectly, the control of the voice or instrument by the aid of the eye. On this point we have conducted a number of series of experiments to determine the effectiveness of such training as evidenced, *e. g.*, by the kind, the rate, the degree, and the permanence of the improvement gained by practising with the instrument. The first of these series was begun in 1903; from that time up to the present, experiments in the training of pitch control have been in progress continuously for purposes of developing methods and means and testing results. Laying aside all technical matters and detail, we may glean from these experiments the following points of interest:

Practically all singers—good, bad, or indifferent; trained or untrained; child or adult; professional and non-professional—will improve in pitch control by training with the instrument. He who can not sing a tone may "find" himself by the eye; the average singer is slovenly about pitch until shocked by what he sees in the projected voice; the person who can sing to a high degree of accuracy—say an error of plus or minus one vibration—has abundant room for improvement within a fraction of a vibration, for the more accurately one sings, the finer the instrument registers.

The gain in training by aid of the eye may be attributed in large part to the recognition of certain subjective and objective sources of error which may be eliminated after discovery by the instrument. The ear unchecked is lax in its control of pitch. When the eye reveals an error in pitch, it aids the ear in identifying and making concrete the elements of hearing which had before remained undifferentiated and unrecognized. The seen tone serves both as a whip and as a guide in pitch near the lower limits of the ear, and is, therefore, the best incentive for improvement. Among the objective disturbances are the effect on pitch of the loudness of the keynote heard, the loudness of the note sung, the quality of the tone heard, the quality and register of the tone sung, the vowel of the syllable sung, the duration of the tone, etc. Among the subjective factors the most complicated one is the factor of effort of attention. Ordinarily one sings more accurately when he tries; yet when one comes to a certain stage he will sing better if not conscious of a specific effort to sing in pitch. Fears, theories, anticipations and illusions also modify the pitch. Under certain circumstances accuracy in pitch may be a mark of the general condition of the system.

Training with the eye improves the ability to form concepts of intervals and sing them with increasing accuracy. Who can sing, or knows when he has sung, the chromatic scale or even a single half tone? With the instrument he can place the exact note in tempered scale or in just intonation and study in detail effect after effect and control for mastery with the instrument which registers much finer distinctions than the ear can hear. Here again we have found that there is room for improvement for all. One man who thought he was tone-deaf was trained to sing a tone interval with a high degree of accuracy. One well-known singer was struck with despair when she saw how badly she sang the natural scale.

Training the ear with the eye enhances its ability in voluntary control of the voice as in raising and lowering of the pitch. The improvement in this is astonishingly rapid; and the reason for all this rapid improvement lies in the fact that one sees the tone the moment he sings and hears himself sing it, and can at will identify the direction and exact amount of the error. As has been pointed out, this seeing of the tone serves as a whip and also as a guide to specific effort.

Striking a note may be fractionated, *i. e.*, separated into its parts so that one may study from moment to moment, the attack, the release, and the sustaining (with its various periodic or progressive changes in pitch, both desired and undesired). The instrument enables the singer to take each of these in turn and establish mastery under the criticism and guidance of the eye.

The gain made in singing with the aid of the eye is transferred into auditory and motor control. The improvement which takes place in singing with the instrument is very rapid and one would, therefore, suspect that

it would not be permanent. But experiments show that if the training is continued for a few days with the instrument, the gain will be transferred to the ordinary singing without the instrument. This is the most encouraging feature in the process and deserves to be analyzed in great detail for the purpose of a pedagogy of singing; this we are now attempting to do in the laboratory. Such questions as these arise: How is association transferred from the visual to the auditory-motor? What are the common elements in visual and auditory control? How can we isolate each of these factors for the purpose of reduction of error?

This type of training is convenient, inexpensive and rigid. The pupil may be assigned any one of a hundred exercises in pitch training and practise all by himself under correction at every tone production; it may be to reduce a tendency to sharp or flat, to eradicate a tremulo, to gain control of a vibrato, or any other pitch figure the master may set. It gives opportunity for control drill under the severest correction at every stage.

Carl E. Seashore
University of Iowa

ORVILLE A. DERBY

In November last the newspapers published a cablegram from Rio de Janeiro announcing the suicide of Orville A. Derby, director of the Brazilian Geological Survey. Letters from mutual friends have now thrown all the light on the subject that we can reasonably expect to get.

Mr. Derby first went to Brazil in 1870 as student assistant of Charles Fred Hartt, who was then professor of geology at Cornell University. He made two other vacation trips to that country, and went to Brazil finally in 1875 to be assistant geologist to the newly established geological survey of the Empire, and lived there the rest of his life. In 1877 the survey was suspended, and Professor Hartt, its director, died at Rio. Mr. Derby was shortly thereafter appointed curator of geology in the National Museum at Rio, and held that position until 1886 when he was put in charge of a newly established geological survey of the state of S. Paulo, a position he held until 1904. In 1907 a new federal survey was provided for under Dr. Miguel Calmon, minister of public works, with Derby as its chief.

The war in Europe disturbed the financial equilibrium of South American countries as well as that of other parts of the world. Brazil was probably obliged to economize wherever it was possible to do so, and this led to the reduction of appropriations for the work of the geological survey to such a point as to destroy the efficiency, and even to threaten the existence of that organization. Probably the necessity for such economies was not apparent to Mr. Derby, and he looked upon them as an attempt to discredit him and the bureau under his direction. In any case he took the matter very much to heart, and his friends find no other reason, or shadow of a reason, for his suicide.

Mr. Derby never married, and he led the solitary life of a recluse and student. He was held in the highest esteem by all who knew him. His whole life was given to the study of the geology of Brazil, and no one, living or dead, knew it as he did, or was more profoundly or more unselfishly interested in it. At the time of his death he had published more than a hundred and twenty-five papers on the geology of Brazil, many of them in the Portuguese language, which he wrote with ease.

His successor as the director of the geological survey of Brazil is Dr. L. F. Gonzaga de Campos, one of the ablest and most trustworthy of the Brazilian geologists, and for many years one of Mr. Derby's most competent assistants.

A fuller account of his life and work will be published in the *Bulletin* of the Geological Society of America.

John C. Branner
Stanford University, Cal.

PARIS-WASHINGTON LONGITUDE[1]

Director B. Baillaud, of the Paris Observatory, presented the results of the determina-

[1] Translation from *Comptes Rendus de l'Academie des Sciences*, February 14, 1916.

tion of the difference of longitude between the observatories of Paris and Washington, as deduced under the direction of M. Renau, who makes the following statement:

It is now three fourths of a century since the first attempts were made to connect Europe and America in longitude. Gilliss in 1838, by meridian observations of the moon, and later Walker, Peirce, and others, by means of eclipses and occultations, obtained results which were not accordant and showed a range of 2.5 seconds.

About 1849 new determinations were made with the aid of chronometers, but these gave results of little greater precision. Since 1866, several determinations were made by the exchange of telegraphic signals. Gould in 1866, Dean in 1870 and Hilgard in 1872 determined the difference between Cambridge and Greenwich. Hilgard in 1872 determined the difference between Cambridge and Paris, and in 1892 a determination was made between Montreal and Greenwich.

In 1912 Captain Jayne, superintendent of the Naval Observatory, with the approval of the Acting Secretary of the Navy, proposed that a determination be made of the difference of longitude between the observatories of Paris and Washington.

Early in 1913 the Bureau of Longitudes began to study the conditions under which this important work could be undertaken. For some years Messrs. Claude, Driencourt and Ferrié, had been developing the idea of applying radio signals to the determination of the differences of longitude, and due to their remarkable initiative the observatory had been able to successfully measure the differences between Paris–Bizerta, and Paris–Uccle, in 1911 and 1912.

These previous operations seemed to fix the most suitable methods, and to assure the success of the undertaking, though it was necessary to take account of the difficulty of hearing radio signals at a distance of 6,175 kilometers.

Operations began in October, 1913, and continued until early in March, 1914, with an interchange of observers near the middle. The astronomical observations were most satisfactory. It was not until after the middle of November that satisfactory exchanges of radio signals were effected.

Owing to the perfect installations of the clocks at Paris and Washington, which enabled their rates for many days to be determined with a precision at least equal to that of the observations, it was found possible to utilize the evenings on which radio signals were exchanged, when astronomical observations were made at one station only (incomplete), as well as those when such observations were made at both stations (complete).

In the first part of the operations, 7 complete and 14 incomplete evenings were secured and in the second part 10 complete and 20 incomplete evenings were secured. The results are as follows:

Complete Evenings

	h	m	s
First part	5	17	36.53
Second part	5	17	36.75
Weighted mean	5	17	36.65

For all Evenings

	h	m	s
First part	5	17	36.53
Second part	5	17	36.75
Weighted mean	5	17	36.67

The value $5^h\ 17^m\ 35^s.67$ is adopted as the definitive result of our work.

The difference $0^s.22$ between the results of the first and second parts should not be regarded as excessive in view of the peculiar conditions of the enterprise and of the difficulty of the exchange of radio signals. It does not seem capable of explanation without further labor.

In a preliminary publication of the results of the work of the American astronomers, the definitive result is given as $5^h\ 17^m\ 36^s.62$[2] which is within $0^s.01$ of our result, and there is a precisely similar difference between the two parts, $36^s.56$ and $36^s.76$, corresponding to $36^s.53$ and $36^s.75$ as given above.

[2] *Astronomical Journal*, March 15, 1915.

SCIENTIFIC NOTES AND NEWS

Members of the National Academy of Sciences have been elected, as follows: Gregory Paul Baxter, professor of chemistry, Harvard University; Gilbert Ames Bliss, professor of mathematics, University of Chicago; Marston Taylor Bogert, professor of organic chemistry, Columbia University; Otto Folin, professor of biological chemistry, Harvard Medical School; Leland Ossian Howard, chief of the Bureau of Entomology, U. S. Department of Agriculture; Phoebus Aaron Theodore Levene, member in biological chemistry, Rockefeller Institute; Alfred Goldsborough Mayer, director of the department of marine biology, Carnegie Institution; Raymond Pearl, head of the department of biology, Maine Agricultural Experiment Station; Frank Schlesinger, director of the Allegheny Observatory, University of Pittsburgh.

At the recent meeting of the American Philosophical Society, members were elected, as follows: William Wallace Atterbury, railway engineer, Philadelphia; Maxime Bôcher, professor of mathematics, University of Chicago; Percy Williams Bridgeman, professor of physics, Harvard University; James Mason Crafts, professor emeritus of organic chemistry, Massachusetts Institute of Technology; Henry Platt Cushing, professor of geology, Adelbert College, Western Reserve University; Edward Murray East, professor of experimental plant pathology, Bussey Institution, Harvard University; Frank Rattray Lillie, professor of embryology, University of Chicago; William E. Lingelbach, professor of modern history, University of Pennsylvania; Daniel Trembly MacDougal, director of the department of botanical research, Carnegie Institution; Charles Frederick Marvin, director of the U. S. Weather Bureau; Lafayette Benedict Mendel, professor of physiological chemistry, Yale University; Forest Ray Moulton, professor of astronomy, University of Chicago; Eli Kirk Price; Erwin Frink Smith, pathologist in charge, laboratory of plant pathology, U. S. Department of Agriculture; William Morton Wheeler, professor of economic entomology, Bussey Institution, Harvard University. Foreign residents were elected as follows: Frank Dawson Adams, professor of geology, McGill University; Wilhelm L. Johannsen, director of the plant physiological laboratories, University of Copenhagen; Joannes Diderik van der Waals, professor of mathematical physics, University of Amsterdam.

The board of directors of the Hospital for Deformities and Joint Diseases announces that a dinner will be given to Dr. Abraham Jacobi at the Ritz Carleton Hotel on May 3. Dr. Levi Strauss is chairman of the dinner committee.

Professor Antonio Berlese, of Rome, and Dr. L. O. Howard, of Washington, have been elected to honorary fellowship in the Entomological Society of London to fill the vacancies caused by the deaths of J. H. Fabre and Brunner von Wattenwyl.

Dr. Arthur D. Little, of Boston, has been placed in charge of the organization of a Canadian Research Bureau in Montreal which will aim to coordinate the work of scientific men and experts engaged in research work in all parts of the Dominion.

Dr. J. C. Cain has been appointed chief chemist of the British Dyes, Ltd., at present under construction at Dalton, Huddersfield.

Dr. Charles G. Wagner, superintendent of the Binghamton, N. Y., State Hospital for the Insane, was elected president of the American Medico-Psychological Association, at the seventy-second annual meeting held in New Orleans, on April 5.

Dr. James V. May, head of the New York State Hospital Commission, was recently appointed superintendent of the Grafton, Mass., State Colony for the Insane, succeeding Dr. H. Louis Stick, whose resignation was accepted in March.

Mr. Carl Whiting Bishop, of the University of Pennsylvania Museum, has returned to Pekin after three months of exploration in Szechuen province. Mr. Bishop was at Chengtu, the capital of Szechuen province, and traveled some distance northwest from

that point to examine old ruins and make archeological studies.

DR. FRANK A. HERALD has recently returned to America from China, where he has been making geological investigations of the possibilities of oil and gas fields for the Standard Oil Company of New York.

THE staff of the Iowa Lakeside Laboratory of the University of Iowa, on Lake Okoboji, Iowa, will be as follows for 1916: Director, B. Shimek, University of Iowa; zoology, T. C. Stephens, Morningside College; geology, J. L. Tilton, Simpson College; botany, A. F. Ewers, McKinley High School, St. Louis; zoology during August, F. A. Stromsten, University of Iowa. Assistants, D. H. Boot, Zoe Frazier, Eva Cresswell, W. J. Himmel. The regular summer session, during which courses will be offered, will run from June 19 to July 31. The usual research session will be held during August.

THE annual address of the Pathological Society of Philadelphia was delivered by Dr. William H. Park, New York, at the College of Physicians and Surgeons, on April 27.

THE annual Cutter lecture, on "Preventive Medicine and Hygiene," was delivered at the Harvard Medical School on Monday, April 3, by Dr. George W. McCoy, director of the Hygienic Laboratory of the United States Public Health Service. Dr. McCoy, formerly superintendent of the leper colony on the Island of Molokai, Hawaii, selected as his topic, "The Public Health Aspects of Leprosy."

THE tenth Harvey lecture was given at the New York Academy of Medicine, on April 8, by Professor Stanley R. Benedict, of Cornell University, his subject being: "Uric Acid in its relation to Metabolism."

PROVOST EDGAR F. SMITH, of the University of Pennsylvania, was the guest of honor on Founder's Day at Juniata College on April 17, when they dedicated their new science hall. Dr. Smith delivered the principal address, his subject being "A Tribute to the Sciences."

THE seventh of the exchange lectures between the University of Wisconsin medical department and the Marquette University medical school was given by Dr. W. J. Meek at Milwaukee on April 19, on "The Physiology of Adrenelin." The previous lecture was given by Dr. C. R. Bardeen on "The Physical Basis of Heredity."

UNIVERSITY AND EDUCATIONAL NEWS

THE state of New Jersey has recently appropriated the sum of $4,000 to aid in establishing a course in sanitary science to be affiliated with the course in biology at Rutgers College.

NEW YORK UNIVERSITY has concluded an arrangement with the Brooklyn Botanic Garden whereby research courses in botany will be conducted at the garden and credited in the biology department of the university's graduate school. Plant-breeding and plant-pathology will be the principal fields of investigation. The Botanic Garden is a department of the Brooklyn Institute of Arts and Sciences. Its agreement with the university, entered into "for the purpose of encouraging botanical investigation," provides that the instructors in this research work will have the rank of "lecturer" in New York University and the students' work will count for an advanced degree.

The British Medical Journal states that the late Mr. Stanley Boyd left an estate valued at £32,646. After providing for certain legacies he left the residue of his property in trust for his mother and sister and the survivor of them, and subject thereto he gave £2,100 to Epsom College for one foundation scholarship, and the ultimate residue to the University of London for the endowment of a professorship of pathology in the Medical School of Charing Cross Hospital. Out of the property bequeathed to him by his wife he gives a number of legacies to her relatives, £1,000 each to the London School of Medicine for Women, the New Hospital for Women and the Pathological Department of the New Hospital for Women, and any residue to the New Hospital for Women.

THE board of governors of the Western University, London, Ont., has purchased a large

farm near that city for the erection of a new university. The location consists of 100 acres overlooking London. Building operations will not be commenced until the end of the war, but plans will be prepared and the grounds laid out.

Cassius Jackson Keyser, professor of mathematics in Columbia University, and M. W. Haskell, professor of mathematics in the University of California, will exchange chairs for the half-year from August to December, 1916.

Mr. Eliot Blackwelder, professor of historical geology at the University of Wisconsin, has been appointed professor of geology and head of the department, at the University of Illinois. The appointment will take effect on September 1.

There have been promoted to assistant professorships at Yale University, Joshua Irving Tracey, Ph.D., in mathematics and Alexander Louis Prince, M.D., in physiology.

At Rutgers College, Dr. F. E. Chidester, associate professor of zoology, has been advanced to a professorship and made chairman of the course in biology; Dr. A. R. Moore, associate professor of physiology at Bryn Mawr, has been made professor of physiology and head of the newly created department of physiology; and Richard Ashman has been appointed assistant in zoology.

Dr. Wilbur A. Sawyer has been appointed clinical professor of preventive medicine and hygiene in the University of California. He will continue also his work as secretary and executive officer of the California State Board of Health. The object of the creation of this new department is to bring about the most effective possible cooperation between the University of California and the California State Board of Health. The new department will include in its staff Dr. James G. Cumming, director of the Bureau of Communicable Diseases of the State Board of Health, who will become also assistant professor of preventive medicine and hygiene, and, as lecturers in preventive medicine and hygiene, Dr. William C. Hassler, Dr. John N. Force, Dr. Jacob N. Geiger, assistant director of the Bureau of Communicable Diseases, and Chester G. Gillespie, C.E., director of the Board of Sanitary Engineering of the California State Board of Health.

Among promotions at Stanford University are: To the rank of associate professor, John P. Mitchell in chemistry, Leonas L. Burlingame in botany and Rennie W. Doane in entomology; to rank of assistant professor, Hayes W. Young in metallurgy, John F. Cowan in surgery and Perley A. Ross in physics.

DISCUSSION AND CORRESPONDENCE

THOSE FUR SEAL BONES

"Millions of dollars' worth of seal and sea lion bone deposits on the shores of the Pribilof Islands, a vast store of government-owned fertilizer available for practical use," is the way the Washington dispatch of February 28 comments on a report said to have been made by the secretary of commerce to the House committee on merchant marine. One of these deposits is said to be "a mile long by half a mile wide and fully six feet deep." This suggests 83,000,000 cubic feet of bone—a wonderful deposit, indeed! To complete the picture it is stated that raw ground bone was bringing $35 a ton in December.

This sounds like a very important discovery. It will be too bad if it proves not to be true. The dispatch indicates that the deposits "have not been fully surveyed." It is to be feared that the completed surveys will be disappointing.

It is a fact that since the discovery of the Pribilof Islands in 1786 upwards of 5,000,000 fur seals have been killed and their carcasses left to rot on the killing grounds. These are the bones which are referred to. There are no prehistoric bones, since the death of the adult animals from natural termination of life is at sea, under the stress of the winter migration. Of the five million animals killed about one half were deposited on the great killing ground near the village on St. Paul Island.

The rest are distributed over a considerable number of widely separated fields, for the most part unimportant.

The adult male fur seal attains a weight of 400 to 500 pounds, and if this were the class of animal killed, a considerable deposit of bone would have resulted from the carcasses of the five million animals. It is, however, the immature males of two and three years that have been killed. These are animals of 50 to 60 pounds weight and their bones still contain a large proportion of animal matter. The seal is an animal adapted for life in the water, like a fish, and its bones are small and fragile. In a green state they constitute perhaps ten pounds of the weight. Weathered for a few seasons on the sands of St. Paul, or otherwise dried out, they would not exceed three to five pounds in weight. In other words 500 of the animals might give a ton of bone, if it was regularly cared for. Left to chance, the yield would naturally be less. The five million animals would therefore at best represent about 10,000 tons of bone, or at the price of $35 a ton suggested, a total value of $350,000. Half of this would be found in the St. Paul village deposit. This is on the assumption that something like the full product of bone could be recovered.

It would not be all profit; there would be expense in getting the bone out, and especially in shipping it to some commercial port. The Pribilof Islands have no harbors. Ships must anchor a mile or so off shore and all cargo must be lightered in or out in small boats. The islands are small and a few hours' stiff wind will break up a landing any day, twenty-four hours', all landings. On the approach of a storm the ship must pull anchor and put to sea. Fogs are frequent and persistent and a vessel may have to wait days for an observation of the sun to enable it to find its way back to the islands. In the summer of 1914 the supply ship of the department of commerce spent 23 days, at a cost to the government of $250 a day, about these island in landing a cargo of a few score tons of freight. The revenue cutter service in 1911 left the bones of a good ship on one of the reefs of St. Paul. The getting of this supply of bone out (assuming that its exists) would be a thing fraught with difficulty and danger.

But the most probable thing about the whole matter is that the bone deposit does not exist. In the season of 1912 the writer witnessed the sinking of a six foot trench through a considerable portion of the main field of alleged deposit for the purpose of laying a water pipe. No bone was found except at or near the surface and here in negligible quantity. This was a matter of surprise and comment because on theoretical grounds we had expected to find layer on layer of bones representing the successive annual killings which had been going on here for over a century. Nothing, however, was found but the coarse lava sand which underlies the field to a depth of fifteen to twenty feet. Into this sand, evidently, the rain has washed the dust of the bones as they quickly disintegrated.

A more tangible thing associated with this great killing field of St. Paul Island is the oil, rendered by the elements from the blubber encasing the seal carcasses. This has soaked into the ground and mingled with the water that underlies the field giving to it the appearance of thick brown soup. The villagers of St. Paul have had to locate their wells far beyond this field to get pure water. A claim that there were millions of dollars' worth of seal oil stored in reservoirs underneath the Pribilof Island killing fields would have had a more solid basis of fact to rest upon. Perhaps the revelation of this great natural resource is held in reserve.

One interesting thing in connection with these rather mythical bone deposits of the seal islands is that since 1912 no additions have been made to them. The fur seal law of that year stopped commercial sealing. In 1911 the last deposit—the bones of 12,000 seals—was laid down; it represented about thirty tons of dried bone, worth, at $35 a ton, about $1,050. Incidentally the 12,000 seal skins taken from these animals brought the government $35 each, or the reputed price of a ton of raw ground bone. The value of the seal skins, which may in this case be considered a

by-product of the government seal boneyard, was $423,000. The bones of 10,000 to 12,000 seals might have been deposited each year since to increase the store of "government-owned fertilizer," but the fur-seal law has prevented the secretary of commerce from killing them. In addition to the loss of the bone, there has been the loss in seal skins, which in the meantime have risen to a price of $50 each. Incidentally these seal skins, if they could be taken, would also be valuable cargo for the ships "that may be provided by the pending administration ship purchase bill," and less troublesome than bone to handle.

George Archibald Clark

MATERIALS IN A TON OF KELP

The seriousness of the current shortage of potash gives increased importance to a careful consideration of the American sources of it. The following table gives in pounds the quantities of the materials mentioned that are contained in a ton (2,000 pounds) of fresh kelp. The three species mentioned are the ones that are harvestable in commercial quantities along the Pacific coast of North America. The supply available on the California coast is mainly *Macrocystis*, that in the Puget Sound region is mainly *Nereocystis*, while that in southern Alaska is *Nereocystis*, *Macrocystis* and *Alaria*. In western Alaska the supply is *Nereocystis* and *Alaria*.

	Water	Potassium Chloride	Other Salts	Iodine	Algin	Crude Fiber	Nitrogen
Nereocystis luetkeana	1,834	52.7	25.1 to 37.7	0.22	23.4	8.4	2.9
Macrocystis pyrifera	1,736	52.5	26.7 to 55.7	0.61	44.4	19.3	4.3
Alaria fistulosa	1,726	39.3	27.6	Trace	No data	No data	7.1

The computations are made from data obtained by workers in the United States Bureau of Soils, the University of California and the University of Washington.

The algin here reported is the adhesive material that can be dissolved in sodium carbonate and precipitated with acids. The crude fiber reported was approximately half cellulose.

George B. Rigg
University of Washington

THE TOXICITY OF BOG WATER

The writer has found by experiments that filtered bog waters show a precipitate when saturated with ammonium sulphate, disodium hydrogen phosphate, or sodium chloride. The filtrate from this when freed from the salt by dialysis did not prove toxic in solution cultures to the root hairs of *Tradescantia*, while the untreated bog water did prove toxic. The matter precipitated by these salts is not volatile at 100° C.

Since the specific gravity of bog water is 1.000, and its osmotic pressure is very low it seems probable that the substances present in this water are in a colloidal state. The above data tend to confirm this view and suggest that the colloidal matter may be a large factor in the toxicity of bog waters.

The waters used were obtained from sphagnum bogs in the Puget Sound region and Alaska.

George B. Rigg
University of Washington

EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY

To the Editor of Science: The sixty-first annual exhibition of the Royal Photographic Society will be held as usual in August and September of this year. In order to facilitate the collection and forwarding of scientific exhibits I have been appointed one of the judges in the scientific section of the forthcoming exhibition and have made arrangements to receive photographs from American workers and to forward them to London, thus relieving the photographer of all difficulty and expense.

I should be very glad to hear from any American photographer who wishes to enter photographs in the scientific section of the exhibition of the Royal Photographic Society and to forward him an entry form.

For some years now the American exhibit in the scientific section has been a comprehensive one and of great interest to European workers

as showing what has been done on this side of the Atlantic, and it is earnestly desired by the council of the Royal Photographic Society that the United States should continue to be fully represented in this exhibition.

C. E. K. MEES

KODAK PARK,
ROCHESTER, N. Y.

THE CARNEGIE FOUNDATION

THE president of the Carnegie Foundation for the Advancement of Teaching has printed and distributed a long discussion of the policies of the foundation. Although this has been sent to thousands of teachers it is curiously, but characteristically, marked "Confidential." As it can not be discussed directly, the writer has reprinted the articles on the subject which appeared in SCIENCE several years ago and will be glad to send a copy to any reader of this note who may care to ask for it. It is desirable at least to watch the Greeks, both when they bear gifts and when they take them away.

J. MCKEEN CATTELL

GARRISON-ON-HUDSON, N. Y.,
April 15, 1916

SCIENTIFIC BOOKS

The Telephone and Telephone Exchange, Their Invention and Development. By J. E. KINGSBURY, M.I.E.E. Longmans Green & Co. 1915. Cloth. 558 pages, 170 illustrations. Price $4.00 net.

Considering that the telephone, in its serviceable form, is an American invention; that the telephone switchboard and exchange were first developed in America, and that the number of telephones per unit of population is much greater in America than in any other part of the world, it is remarkable that this is the first book that pretends to give a comprehensive outline of the history of telephonic development, and that this first book should have been written in England. This is an index of the general condition of inventors, engineers and engineering, all the world over. As a body, engineers are rarely gifted with talents for literature, or for historical research; yet collectively, they have transformed the surface of this planet, and have revolutionized its modes of living. However, if one should ask of a local resident near some monumental structure, grand bridge, or imposing viaduct, as to who erected it, the answer would be likely to be limited to the name of a capitalist.

This book traces very entertainingly the development of the Bell telephone, from its early conception in the mind of the inventor, to the standard instrument on so many a table of to-day. The author modestly disavows the title "history" for his book. Nevertheless, a very large amount of historical research must have been carried on by him, in order to make up the interesting narrative contained in these pages.

The following list of chapter headings will convey an idea of the scope of the historical work: Introductory, The spoken word, The growth of an idea, The undulatory current, The solution of the problem, Development and demonstration, The production of a commercial instrument, The application to commercial uses, The telephone exchange, The battery or variable-resistance transmitter, The microphone, Philipp Reis and his work, Call bells, The telephone switchboard, The organization of the industry in the United States, Competition, Consolidation and development, Introduction of the telephone in Europe and abroad, Public apathy and appreciation, The multiple switchboard, Outside or line construction, Ten years' progress, The Development of dry-core cable, Early exchange systems, Telephone engineering on a scientific basis, The branching system, The common-battery system, Automatic and semi-automatic switchboards, Long-distance service, Instruments, Rates, The economics of the telephone, The telephone and governments, Conclusion.

The task of considering the invention and development of each individual element in a modern telephone system is a very difficult one. There are so many claimants, and their claims are so antagonistic. The author has carried out this task in his own way, and with a fairmindedness that merits approbation. It

may be urged that, in America, he has not done full justice to the work of the independent telephone companies and their inventors. The great bulk of the development in this country is undoubtedly due to the Bell organization, its pioneers, inventors, organizers, engineers and constructors; yet a very appreciable residual share is due to the competing independent companies. It must be remembered, however, that the author has not had the same opportunity to become acquainted with ultra-Bell sources in America, that he has in Great Britain, but there he has given credit with an impartial pen.

The chapter on the telephone and governments should be studied by those who, as outsiders in telephony, seek to form a just estimate of the relative advantages of governmental versus private-corporation administration. The author knows whereof he speaks, for he has been in intimate touch with telephony in England, both under company operation, and under government operation. He also writes in a fair and open-minded vein. The conclusion which is apparently unavoidable is that governments are not able to operate a country's telephone system so efficiently, economically or progressively as a private corporation under government control. For this conclusion, there is certainly abundant evidence. In Europe, where the governments almost invariably operate the systems, the only country in which it appears that the telephones are in private hands, is Denmark. Denmark is accorded 4.5 telephones per hundred of population; whereas the highest use in any government-operated country is 2.1 (for the German Empire). In the United States, the number given is 9.7 per hundred, or more than double Denmark's.

The book is almost the only history of its kind, and is a welcome addition to the literature of telephonic growth and development.

A. E. Kennelly

An Introduction to the Principles of Physical Chemistry. By Edward W. Washburn. New York, McGraw-Hill Book Co., Inc., 1915. Pp. xxv + 445.

This volume constitutes a marked departure from the conventional method of treatment which most authors have followed under the influence of the early spirit of physical chemistry which found concrete expression in Ostwald's "Lehrbuch der allgemeinen Chemie." Many years have elapsed since this epoch-making work appeared and many important contributions have been made to our knowledge of the subject in the meantime. The controversies, however, which arose in the early development of physical chemistry, have been so prolonged that most writers have confined themselves to the outline of the subject as established by precedent and have found little opportunity to lay before the student the more recent developments in this field. In this respect the present volume is a welcome addition to the literature. The treatment of the subject is distinctly along original lines.

The book is well written, and the subject-matter is presented in a manner which retains the interest of the reader. A large number of very excellent figures are given, many of them being original. The numerous problems appearing throughout the text are well selected. The biographical references will prove of interest to the student. A later edition should give reference, however, to Mayer, Joule and Helmholtz, in connection with the first law of thermodynamics. The reference to J. Willard Gibbs as "one of America's greatest chemists," fails to recognize the importance of Gibbs's work along other lines than those of chemistry. References to the literature are numerous and add greatly to the value of the text. Cross references are frequent, but references to page and section would be more convenient than references to chapter and section. Misprints and other minor defects are much less common than is usual in first editions.

The division of the subject-matter is excellent, on the whole, but it is to be noted that the greater portion of electrochemistry is omitted. Gaseous equilibria, in fact, equilibria in general, with the exception of electrolytic equilibria, are treated very briefly. The Nernst heat theorem is not mentioned, al-

though specific heats are discussed at some length.

Nearly all of the important physical chemical relationships are expressed in mathematical form. The derivation of those relationships which are based on thermodynamic principles is given in an appendix. The differential equations are obtained by means of an ingenious device termed a "Perfect Thermodynamic Engine," which appears to be a modification or rather an amplification of the familiar cyclic process. This method of treatment should be of great service to those students who lack the analytical turn of mind.

As stated in his preface, the author has made a radical departure from the classical treatment of the second law of thermodynamics. He has attempted to formulate this law in mathematical form by means of elementary kinetic considerations. The Carnot cycle has been entirely omitted. The wisdom of this procedure may be questioned, for the method involving Carnot's cycle is both simple and instructive. It brings out, moreover, the important fact that the second law is a principle of that general character which is not dependent upon the mechanism involved in a given process, and that conversely it can give us no information as to the character of the mechanism involved therein. The necessity of supplementing thermodynamics with results obtained from the kinetic hypothesis is thus almost self-evident, but it is well to avoid leading the student to infer that simplicity is one of the chief virtues of the statistical method. The author's argument on pages 104 and 105 is not over clear. The two processes there described are not identical as to initial and final conditions, nor is it apparent how these two processes are related to each other. The treatment given tends to confuse the work of a Carnot's cycle with the second law of thermodynamics, while it does not clearly point out that the second law involves an inequality, not an equality. The entropy function, which is of fundamental importance in the treatment of the second law, is nowhere mentioned, nor is the Helmholtz equation formulated.

The subject of solutions is treated at length and from a much more general point of view than is commonly the case. Electrolytic solutions, so far as aqueous solutions are concerned, are fully treated. An excellent discussion is given of equilibria involving the ions of water, including hydrolytic and indicator reactions.

In treating the phase rule the author introduces the composition number, which is the mol-fractions of the smallest number of molecular species present in a given phase which must be specified in order to fix the composition of the phase in question. The composition number of a system is defined as "equal to the largest composition number of any of the phases of the system." The last definition leads to a certain restriction of the phase rule which is avoided in the usual method of treatment. This becomes clear in the case of a two component system in which the three phases present in equilibrium are all pure substances, as, for example, in the system, $CaCO_3$, CaO, CO_2. The author's definition leads to the necessity of considering that one of the phases contains all of the substances in question, for example, that the vapor phase contains $CaCO_3$ and CaO as well as CO_2.

In the discussion of the composition-temperature diagram of solid solutions (p. 356), the author has failed to give the interpretation of the field lying between the curves for the solid and liquid solutions. A few other minor corrections may be noted. The definition of the viscosity coefficient (p. 51) is in error; the maximum work is not clearly distinguished from the free energy (p. 110); the terms "divariant" and "binary," "trivariant" and "ternary," etc., are confused with each other (p. 342).

The book comprises 27 chapters and an appendix, and covers the entire field with the exceptions noted above. It is only in exceptional instances that anything but the most favorable criticism can be made. The author has made an important contribution to the list of texts available for the use of students. The volume should find its way generally into the chemist's library. In the hands of a compe-

tent instructor it should prove an admirable text for classroom use.

Charles A. Kraus

Clark University,
March, 1916

Being Well-Born: An Introduction to Eugenics. By Michael F. Guyer, Ph.D. Indianapolis, The Bobbs-Merrill Co., 1916. 374 pages. $1.00.

This is one of the later volumes in the extensive "Childhood and Youth Series" edited by M. V. O'Shea. The general purpose of this series is "to give to parents, teachers, social workers and all others interested in the care and training of the young, the best modern knowledge about children in a manner easily understood and thoroughly interesting." The special purpose of this volume is "to examine into the natural endowment of the child" and to give "an account of the new science of eugenics." There is some reason for thinking that the value of Professor Guyer's work would not have been lessened, had he been entirely freed from the special purposes and influences of the "Series." As it stands, however, the work has very distinct merit and a high degree of usefulness.

In its general plan the book does not differ materially from other "Introductions" to the hybrid science of eugenics, although certain phases are treated with more than the usual detail. The work may be divided into three parts. The first, including the first four chapters, deals with the subject of heredity, its definition, cytological basis and Mendelian descriptions. This is the clearest cut and most authoritative section, well adapted for the student class. The reviewer's experience, however, leads him to believe that the average reader of the class for whom it is intended, will find even these clear descriptions too difficult really to be comprehended without the added services of an experienced guide. The glossary which is appended will aid in assisting the uninitiated over the difficult spots. The attempt to explain the inheritance of sex and of sex-linked characters, before the principles of Mendelism have been discussed is unusual. It is of interest to note that, wisely, only four pages are given to the statistical descriptions of heredity, and that the author takes a conservative position regarding the Mendelian interpretation of some of the data from the Eugenics Record Office.

The second group of four chapters sets forth some of the implications of the facts described in the first section, as they are related to the characteristics of the individual. Two long chapters entitled "Are Modifications Acquired Directly by the Body Inherited" and "Prenatal Influences" are certain to be of very great value to the general reader. The materials are well considered, lucidly presented and a clear distinction made between the scientific and the superstitious conceptions of prenatal influence. This is a subject upon which popular ideas seem hopelessly confused and Professor Guyer has done well to devote so much space to their consideration. The chapter on "Responsibility for Conduct" is less direct and logical, leaving the reader in some doubt as to whether the author's conclusion that "All normal men are responsible for their conduct" is the only one that could be drawn from the evidence given. This is the least satisfactory chapter in the book.

The last section consists of two chapters dealing with the social implications of the facts of heredity. There are very clear and pointed summaries of what is known and of what is believed in this field. The euthenic aspects of the problem are stated and fully credited and the whole discussion is well tempered and sane. Finally the familiar remedies for correcting the antisocial and degenerative process now going forward at so rapid a pace, are discussed. Marriage restrictions and mating systems are recognized as of relatively little practicality; segregation is regarded as hopeful though costly; sterilization as still on trial. Public education and the ensurance of environments that will call forth right reactions seem to offer, for the present, the most hopeful elements in the eugenic program.

The book is well got up, unusually free from errors and the price remarkably low, all of which will add to its well-deserved usefulness and influence.

Wm. E. Kellicott

NOTES ON CANADIAN STRATIGRAPHY AND PALEONTOLOGY. I

Cordilleran Province

IN 1911 and 1912 Dr. R. A. Daly carried on geological studies along the line of the Canadian Pacific railway between Golden and Kamloops, British Columbia, a distance of 224 miles. A preliminary statement of results was published in Guide Book No. 8 of the International Geological Congress and the complete report has recently become available.[1] The transverse section of the eastern half of the Canadian Cordillera thus made known roughly parallels the International Boundary section and is about 120 miles north of it.

Three major geological provinces are recognized. The first of these is that underlain in the main by the Shuswap terrane and includes a portion of the Selkirks and the northern half of the Columbia mountains. The Shuswap rocks are of "Early Pre-Cambrian" age and consist of metamorphosed sediments and volcanics, aggregating over 28,000 feet in thickness, intruded by innumerable sills and laccoliths of granite as well as by batholithic masses of the same plutonic rock. The whole is essentially a very large mass of ideal crystalline schists, the result of static metamorphism. The author very properly makes a distinction between recrystallization which results from deep burial and that accompanying orogenic movement. The former he terms static or load metamorphism, restricting the term dynamic metamorphism to the latter phase. In the alteration of the Shuswap terrane both contact and dynamic metamorphism have played minor parts.

Unconformably overlying the Shuswap schists on the east is an enormous mass of bedded rocks belonging to the Beltian and Cambrian systems. These make up the greater part of the Purcell and higher Selkirk mountains. The Belt series consists of quartzites, limestones, and metargillites attaining a thickness of 32,750 feet and is overlain by 7,750 feet of quartzite referred to the lower Cambrian. No evidence of unconformity between the Beltian and Lower Cambrian was observed. The clastic sediments of these series were derived in the main from the erosion of the Shuswap terrane. The absence of ripple marks and mud cracks leads to the conclusion that most of the Beltian-Cambrian sediments in the region traversed are off-shore deposits. No horizons of playa or flood-plain sediments were identified. Much of the finer quartz silts are believed to have originated as wind-borne dust, blown out to sea. The limestones are interpreted as chemical precipitates resulting from the bacterial decay of animal matter. Extrusive lavas are in some places interbedded with the sediments. The entire series has been moderately metamorphosed and its structure is that of a great synclinorium nearly forty miles broad. East of the Purcell range the Columbia River valley is believed to be underlain by Upper Cambrian and Ordovician beds which have been faulted into contact with the Beltian formations.

West of the Shuswap terrane, Beltian and early Paleozoic rocks are absent, and the upper Paleozoic and younger formations are believed to rest on the pre-Cambrian complex. This constitutes the province of the Interior Plateaus. Its geology is allied to that of the Coast and Vancouver ranges as it is in the western geosynclinal belt of the Cordillera, which forms a strong contrast to the eastern belt. Until the close of Mississippian time the western belt was in the main a land surface, while in the eastern belt sedimentation was in progress. Structural complexity here is of a high order. At the base is the Cache Creek series, 13,700 feet of limestone and clastic sediments, of probably Pennsylvanian age. Unconformably overlying this series are the conglomerates, breccias, sandstones, and massive lavas of the Nicola series. This has an estimated thickness of 5,300 feet and is referred to the Triassic and Jurassic periods. The youngest bed-rock formation in the area is a thick mass of Tertiary volcanics with interbedded sediments, which is believed to be of Oligocene age.

[1] "A Geological Reconnaissance between Golden and Kamloops, B. C., along the Canadian Pacific Railway," R. A. Daly, Geological Survey, Canada, Memoir 68, 1915.

Another important contribution to Cordilleran stratigraphy is that of Dr. S. J. Schofield.[2] Intensive studies of a large portion of the Purcell range south of the Canadian Pacific railway have been carried on for a period of five years. The area mapped includes about 2,500 square miles immediately north of the International Boundary, but the problems encountered involved reconnaissance work extending over much greater areas. The region includes a part of the section traversed by Dr. Daly in 1901 to 1906 and discussed by him in his report upon the geology of the Forty-ninth Parallel.[3] The detailed examinations of the more recent survey make necessary a number of changes in the somewhat tentative correlations and structure determinations of the earlier reconnaissance work.

The bed-rock of the Cranbrook area may be referred to two systems. By far the greater part belongs to the Belt terrane which is unconformably overlain by remnants of Devono-Carboniferous limestones. Neither the base nor the summit of the Beltian system, as determined in the Rocky Mountains, is exposed in the Purcell range. The Purcell series is composed of 22,500 feet of sediments, largely clastic, which by their numerous horizons of mud cracks, ripple marks, casts of salt crystals, and red beds suggest a continental rather than marine origin for most of the strata. Near the top of the series are recurrent basaltic flows whose extrusion was accompanied by the intrusion of gabbro sills. Probably the most significant departure from Dr. Daly's conclusions is that relative to the age of the uppermost of the Purcell formations. In the Forty-ninth Parallel report nearly 11,000 feet of strata were regarded as of Lower and Middle Cambrian age. The later survey has resulted in determining that the entire series is of pre-Cambrian age and that the uppermost beds were deposited some time before the close of Proterozoic times.

Throughout the entire Paleozoic and Mesozoic eras, with the exception of the interval during which marine limestones of Devonian and Mississippian age were deposited, the region seems to have been subject to erosion. Orogenic movements, possibly at the close of the Jurassic period, formed a great series of anticlines and synclines and were followed or accompanied by intrusions of granite bosses and batholiths. Subsequently erosion reduced the area to an old-age topography, which was later uplifted and is now represented by the summit levels of the mountain range. Here, again, Dr. Schofield differs from Dr. Daly, who attempted to explain the present topography in terms of one-cycle erosion. From the excellent illustrations accompanying the report, as well as from the facts cited, the reviewer would agree with the author of the recent memoir. However, the reference of the peneplain to the Cretaceous period does not seem to be justified by the meager data available. The present topography may well have been developed by the dissection of the graded surface since late Tertiary times. A study of the relations of the summit peneplains of the adjacent ranges to the mid-Tertiary lavas of the Interior Plateaus should yield evidence enabling the determination of the dates of rejuvenation.

Quaternary deposits include fossiliferous sands and gravels overlain by glacial drift. The former are presumably of interglacial age and indicate a climate as warm as that of the southern United States at the present time. These are found in the Rocky Mountain Trench, a topographic feature extending from the International Boundary northward into Alaska, which is believed to be the result of erosion controlled by fault planes.

Paleozoic Strata of Central Canada

The "Hudson Bay Exploring Expedition" of 1912, under the leadership of J. B. Tyrrell, secured collections of fossils from the little-known region which forms the southern shore of Hudson bay. The collections include a large number of fossils from the Silurian outcrops along the Severn and Fawn rivers as well as certain Ordovician species from the region southeast of Port Nelson in northern Manitoba. These have been described recently by

[2] "Geology of Cranbrook Map-Area, British Columbia," S. J. Schofield, Geological Survey, Canada, Memoir 76, 1915.

[3] Geological Survey, Canada, Memoir 38, 1913.

Dr. W. A. Parks,[4] who recognizes among them 132 distinct forms. Of these 48 are ascribed to known species and 31 are new to science. Gastropods and cephalopods, some of which are of unusually robust proportions, predominate. The general aspect of the Silurian fauna indicates a horizon comparable with the Guelph, while the Ordovician species suggest the fauna of the Trenton.

The upper portion of the Lockport member of the Niagara formation in Ontario is a thin-bedded bituminous dolomite with intercalations of shale. These beds ordinarily attain a thickness of thirty to forty feet, and Dr. M. Y. Williams, who has recently discovered in them an eurypterid horizon,[5] proposes for them the name "Eramosa beds." The eurypterid, a new species of *Eusarcus,* was found near Guelph, Ontario, associated with several brachiopods, a bryozoan, and two species of *Conularia.* The fauna presents a typically Lockport facies, but contains recurrent Rochester forms as well as a single prenuncial Guelph form. The association of the eurypterid with a purely marine fauna is suggestive of a marine habitat for the former, but, contrary to the author's statement, does not necessarily prove such an environment. Such an association might result if non-marine arachnids were washed down a river to the salt waters at its debouchure. Apparently all the specimens of *Eusarcus* are in this instance fragmentary.

For a number of years the Devonian formations and faunas of the western peninsula of Ontario, between Lakes Huron and Erie, have been under investigation by Dr. C. R. Stauffer, whose final report has become available.[6] The formations studied may be arranged in tabular form as follows:

Devonian	Upper	Portage-Chemung?	Port Lambton beds.
		Genesee?	Huron shale.
	Middle	Hamilton	Ipperwash limestone.
			Petrolia shale.
			Widder beds.
			Olentangy shale.
		Marcellus	Delaware limestone.
		Onandaga	Onandaga limestone.
			Springvale sandstone (local facies).
	Lower	Oriskany	Oriskany sandstone.
		Helderberg	wanting, or possibly represented, in part, by the Detroit River series.

The Detroit River series is an eastern extension of the Upper Monroe of Michigan and little light is thrown upon the problem of its correlation. Its fauna in Ontario indicates the same curious mingling of late Silurian and mid Devonian elements which characterizes its occurrence in southern Michigan.[7] Dr. Stauffer apparently favors the reference of the group to the Upper Silurian, but closes his discussion with the statement that it is the "official practise of the Canadian Geological Survey" to treat these beds as part of the Devonian system.

The Oriskany sandstone is separated from subjacent and superjacent beds by unconformities and is believed to be identical in age with the formation of the same name in New York state. Its fauna is distinctly a southern and eastern one, and there is no evidence in

[4] "Palaeozoic Fossils from a Region Southwest of Hudson Bay," W. A. Parks, *Trans. Roy. Can. Inst.*, Toronto, Vol. XI., 1915, pp. 1–96.

[5] "An Eurypterid Horizon in the Niagara Formation of Ontario," M. Y. Williams, Geological Survey, Canada, Museum Bulletin No. 20, 1915.

[6] "The Devonian of Southwestern Ontario," C. R. Stauffer, Geological Survey, Canada, Memoir 34, 1915.

[7] Grabau, A. W., and Sherzer, W. H., Mich. Geol. and Biol. Surv., Pub. 2, Geol. Ser. 1, 1910, pp. 217–221.

support of the supposed mingling of Oriskany and Onandaga faunas at this place. That conception seems to have resulted from the failure to discriminate the lithologically similar Springvale sandstone which is in reality a local facies of the Onandaga.

The Onandaga fauna is composed of three important elements. Many forms lingered over from the Oriskany of this general region. Others seem to be related to the inhabitants of the Lower Devonian embayment of southern Illinois. The most distinctive element is that including the corals; it bears such marked relationship to contemporaneous European faunas as to indicate a shallow-water connection with that continent. The line of migration was probably, as suggested by Weller some years ago, via the Arctic regions and James Bay.

The Delaware limestone of Ontario is essentially the western equivalent of the Marcellus shale of New York. Its fauna is transitional between those of the Onandaga and Hamilton.

The Hamilton fauna is much the same in Ontario as in New York. In the main it is a derivation from the Onandaga fauna but it also contains many immigrants from South America. In one locality the Hamilton rocks are largely limestone and there the resemblance of its fauna to that of the Onandaga is very close.

The Upper Devonian strata are for the most part heavily drift covered and known only from well records. The worms and lingulas of the black shale, correlated with the Huron of Ohio, indicate its contemporaneity with the Genesee of New York. Nothing is known of the fauna from the green shales of the Port Lambton beds.

Quaternary Geology

In the region adjoining the International Boundary between Rainy Lake and Lake of the Woods, unconsolidated deposits of Quaternary age overlie the pre-Cambrian crystalline rocks. The study[8] of the surficial sediments has revealed the presence of a single small remnant of leached and weathered till deposited by probably pre-Wisconsin ice advancing from the Keewatin center. It is overlain by drift, reddish where weathered, but ordinarily gray in its lower portion, which was deposited over the whole region by ice of the Wisconsin stage moving southwestward from Labrador. Shortly after the retreat of this ice the district was invaded from the northwest by the Keewatin ice sheet of the same stage, which deposited calcareous till and boulder-clay and formed a marginal glacial lake. The latter was enlarged as the ice margin withdrew and glacio-lacustrine clays conceal the till over large areas. The clays show seasonal lamination and the reviewer infers from the author's statements that this "Early Lake Agassiz" existed for about 750 years after the withdrawal of the ice before its waters were drained. An interval, sufficiently long to permit of extensive weathering and the establishment of drainage systems, followed the disappearance of this lake and then the region was gradually transgressed by the waters of Lake Agassiz. These advanced southward with increasing depth of the lake as the northward-flowing streams were ponded by a slight readvance of the Labrador ice sheet. The lacustrine sands, gravels, and clays are overlain by Recent deposits of wind-borne sediment and the peat and swamp muck which filled shallow depressions in the lake floor after its waters had drained away.

A less complex series of Quaternary deposits form the surficial materials of the Island of Montreal.[9] Boulder-clay covers the pre-Cambrian and early Paleozoic rocks nearly everywhere on the island and is in some places overlain by the Leda clay and Saxicava sands. Only one drift sheet, the Wisconsin, has been identified. The clays and sands are deposits in an arm of the sea which occupied the St. Lawrence valley during the "Champlain substage" immediately following the retreat of the Labrador ice sheet. Both formations con-

[8] "The Rainy River District, Ontario, Surficial Geology and Soils," W. A. Johnston, Geological Survey, Canada, Memoir 82, 1915.

[9] "The Pleistocene and Recent Deposits of the Island of Montreal," J. Stansfield, Geological Survey, Canada, Memoir 73, 1915.

tain an abundant fossil fauna, largely of marine molluscs. The Saxicava formation includes beach gravels which are found at 27 different levels of general importance so far as the island is concerned. The highest of these is at an altitude of 617 feet above tide. Postglacial movements are represented by minor faults and folds as well as by the continental deformation which altered the shore-lines of the Champlain sea. The latter is attributed to isostatic adjustment consequent upon the removal of the ice-load.

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SPECIAL ARTICLES

THE THEORY OF THE FREE-MARTIN

THE term free-martin is applied to the female of heterosexual twins of cattle. The recorded experience of breeders from ancient times to the present has been that such females are usually barren, though cases of normal fertility are recorded. This presents an unconformable case in twinning and sex-determination, and it has consequently been the cause of much speculation.

The appearance of an abstract in SCIENCE[1] of Leon J. Cole's paper before the American Society of Zoologists on "Twinning in Cattle with Special Reference to the Free-Martin," is the immediate cause of this preliminary report of my embryological investigation of the subject. Cole finds in a study of records of 303 multiple births in cattle that there were 43 cases homosexual male twins, 165 cases heterosexual twins (male and female), and 88 cases homosexual female, and 7 cases of triplets. This gives a ratio of about 1♂♂:4♂♀:2♀♀, for the twins instead of the expected ratio of 1:2:1. Cole then states:

> The expectation may be brought more nearly into harmony with the facts if it is assumed that in addition to ordinary fraternal (dizygotic) twins, there are numbers of "identical" (monozygotic) twins of both sexes, and that while in the case of females these are both normal, in the case of a dividing male zygote, to form two individuals, in one of them the sexual organs remain in the undifferentiated stage, so that the animal superficially resembles a female and ordinarily is recorded as such, although it is barren. The records for monozygotic twins accordingly go to increase the homosexual female and the heterosexual classes, while the homosexual male class in which part of them really belong, does not receive any increment.

[1] Vol. XLIII., p. 177, February 4, 1916.

Cole thus tentatively adopts the theory, which has been worked out most elaborately by D. Berry Hart, stated also by Bateson, and implied in Spiegelberg's analysis (1861), that the sterile free-martin is really a male co-zygotic with its mate.

Cole's figures represent the only statistical evidence that we have on this subject. Let us follow his suggestion and take from the heterosexual class enough cases to make the homosexual male twins equal in number to the homosexual female pairs; this will be approximately one fourth of the class, leaving the ratio 2:3:2 instead of 1:4:2. Which one of these is the more satisfactory sex ratio I leave others to determine; I wish only to point out the fatal objection, that, according to the hypothesis, the females remaining in the heterosexual class are normal; in other words, on this hypothesis the ratio of normal free-martins (females co-twin with a bull) to sterile ones is 3:1; and the ratio would not be very different on any basis of division of the heterosexual class that would help out the sex ratio. Hitherto there have been no data from which the ratio of normal to sterile free-martins could be computed, and Cole furnishes none. I have records of 21 cases statistically homogeneous, 3 of which are normal and 18 abnormal. That is, the ratio of normal to sterile free-martins is 1:6 instead of 3:1.

This ratio is not more adverse to the normals than might be anticipated, for breeders' associations will not register free-martins until they are proved capable of breeding, and some breeders hardly believe in the existence of fertile free-martins, so rare are they.

My own records of 41 cases of bovine twins (to date, February 25, 1916), all examined *in utero*, and their classification determined anatomically without the possibility of error,

give 14♂♂: 21♂♀: 6♀♀. It will be observed that this agrees with expectation to the extent that the sum of the homosexual classes is (almost) equal to the heterosexual class; and it differs from expectation inasmuch as the ♂♂ class is over twice the ♀♀ class instead of being equal to it, as it should be if males and females are produced in equal numbers in cattle. The material can not be weighted statistically because every uterus containing twins below a certain size from a certain slaughter house is sent to me for examination without being opened. Cole's material shows twice as many female as male pairs, and the heterosexual class is about one third greater than the sum of the two homosexual classes. I strongly suspect that it is weighted statistically; the possibility of this must be admitted, for the records are assembled from a great number of breeders. But, whether this is so or not, if we add the sterile free-martin pairs of my collection to the male side in accordance with Cole's suggestion, we get the ratio 32♂♂: 3♂♀: 6♀♀, which is absurd. And if we take Cole's figures, divide his heterosexual class into pairs containing sterile females and pairs containing normal females according to the expectation, 6 of the former to 1 of the latter, and add the former to his male class, we get an almost equally absurd result (184♂♂: 23♂♀: 88♀♀). On the main question our statistical results are sufficiently alike to show that the free-martin can not possibly be interpreted as a male. The theory of Spiegelberg, D. Berry Hart, Bateson and Cole falls on the statistical side alone.

But the real test of the theory must come from the embryological side. If the sterile free-martin and its bull-mate are monozygotic, they should be included within a single chorion, and there should be but a single corpus luteum present. If they are dizygotic, we might expect two separate chorions and two corpora lutea. The monochorial condition would not, however, be a conclusive test of monozygotic origin, for two chorions originally independent might fuse secondarily. The facts as determined from examination of 41 cases are that about 97.5 per cent. of bovine twins are monochorial, but in spite of this nearly all are dizygotic; for in all cases in which the ovaries were present with the uterus a corpus luteum was present in each ovary; in normal single pregnancies in cattle there is never more than one corpus luteum present. There was one homosexual case (males) in which only one ovary was present with the uterus when received, and it contained no corpus luteum. This case was probably monozygotic.

There is space only for a statement of the conclusions drawn from a study of these cases, and of normal pregnancies. In cattle a twin pregnancy is almost always a result of the fertilization of an ovum from each ovary; development begins separately in each horn of the uterus. The rapidly elongating ova meet and fuse in the small body of the uterus at some time between the 10 mm. and the 20 mm. stage. The blood vessels from each side then anastomose in the connecting part of the chorion; a particularly wide arterial anastomosis develops, so that either fetus can be injected from the other. The arterial circulation of each also overlaps the venous territory of the other, so that a constant interchange of blood takes place. If both are males or both are females no harm results from this; but *if one is male and the other female, the reproductive system of the female is largely suppressed, and certain male organs even develop in the female. This is unquestionably to be interpreted as a case of hormone action.* It is not yet determined whether the invariable result of sterilization of the female at the expense of the male is due to more precocious development of the male hormones, or to a certain natural dominance of male over female hormones.

The results are analogous to Steinach's feminization of male rats and masculinization of females by heterosexual transplantation of gonads into castrated infantile specimens. But they are more extensive in many respects on account of the incomparably earlier onset of the hormone action. In the case of the free-martin, nature has performed an experiment of surpassing interest.

Bateson states that sterile free-martins are found also in sheep, but rarely. In the four

twin pregnancies of sheep that I have so far had the opportunity to examine, a monochorial condition was found, though the fetuses were dizygotic; but the circulation of each fetus was closed. This appears to be the normal condition in sheep; but if the two circulations should anastomose, we should have the conditions that produce a sterile free-martin in cattle. The possibility of their occurrence in sheep is therefore given.

The fertile free-martin in cattle may be due to cases similar to those normal for sheep. Unfortunately when the first two cases of normal cattle free-martins that I have recorded, came under observation I was not yet aware of the significance of the membrane relations, and the circulation was not studied. But I recorded in my notebook in each case that the connecting part of the two halves of the chorion was narrow, and this is significant. In the third case the two chorions were entirely unfused; this case, therefore, constitutes an *experimentum crucis*. The male was 10.4 cm. long; the female 10.2 cm. The reproductive organs of both were entirely normal. The occurrence of the fertile free-martin is therefore satisfactorily explained.

The sterile free-martin enables us to distinguish between the effects of the zygotic sex-determining factor in mammals, and the hormonic sex-differentiating factors. The female is sterilized at the very beginning of sex-differentiation, or before any morphological evidences are apparent, and male hormones circulate in its blood for a long period thereafter. But in spite of this the reproductive system is for the most part of the female type, though greatly reduced. The gonad is the part most affected; so much so that most authors have interpreted it as testis; a gubernaculum of the male type also develops, but no scrotal sacs. The ducts are distinctly of the female type much reduced, and the phallus and mammary glands are definitely female. The general somatic habitus inclines distinctly toward the male side. Male hormones circulating in the blood of an individual zygotically female have a definitely limited influence, even though the action exists from the beginning of morphological sex-differentiation. A detailed study of this problem will be published at a later date.

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A CHEMOTROPIC RESPONSE OF THE HOUSE FLY (MUSCA DOMESTICA L.)[1]

IT is generally conceded that the house fly lays its eggs most frequently in fermenting vegetable substances. Of these, fermenting horse manure is most often chosen, and about cities probably ninety per cent. or more of the house flies are bred from this substance.[2]

Although manure varies considerably, depending upon the food, the age and the health of the horse, it seems to be invariably attractive to female house flies, provided it is moist and not very old. The flies come to the manure primarily to lay their eggs, and although they may obtain some food from it, this is only a secondary object.

These general observations, together with some preliminary studies recently published,[3] led me to believe that the house fly was allured to the manure pile by the odor of some volatile chemical substance which was liberated during the early stages of fermentation. Acting on this hypothesis, I have tested during the past summer the response of the house fly to a number of inorganic and organic compounds which occur as products of fermentation in barnyard manures.

This paper is a preliminary statement of the results of these experiments. A more detailed account will be given in another place.

Trap Experiments with Ammonia and Other Chemical Substances

The following chemical compounds were exposed in glass containers in screen-wire-fly

[1] This work was done in the department of entomology, New Jersey Agricultural College Experiment Station, and is published by permission of Dr. T. J. Headlee, entomologist of that station.

[2] Howard, L. O., "The House Fly—Disease Carrier," New York, 1911, p. 7.

[3] 27th Ann. Rpt. N. J. Agr. College Exp. Station, 1914, pp. 396–399.

traps, 9¾ inches high, and 6 inches in diameter at the base: Ammonium carbonate U. S. P. (contained about 97 per cent. of ammonium acid carbonate and ammonium carbamate), ammonium sulphide solution, ammonium hydroxide, ethyl alcoholic solutions of skatol and indol, ethyl alcohol, acetic, formic, butyric and valerianic acids, hydrogen sulphide solution and carbon dioxide. The traps which volatilized carbon dioxide were equipped with Erlenmeyer flask droppers, which delivered dilute hydrochloric acid a drop at a time on to bits of limestone in the pan of the trap. By this method a small but fairly constant amount of carbon dioxide was evolved throughout a number of hours. A trap was similarly equipped for use in the ammonium hydroxide experiment.

The experiments were performed at a place where flies were always present, but never excessively abundant.

Negative results were obtained in all but the ammonium hydroxide and ammonium carbonate experiments. The results of ten ammonium carbonate trap experiments are summarized below.

Material Used in Each Trap	Number of Traps	Duration of Experiments	Number of Flies Caught			
			Males	Females	Sex Undetermined	Total
Ammonium carbonate, 85–234 gm., and water (50–90 c.c.) or without water.	23	51–220 hrs.	16	186	3	205
Control, with or without water (50–90 c.c.)...	17	51–220 hrs.	5	3	4	12

House flies were attracted to the traps which contained ammonium carbonate. Small amounts of water and carbon dioxide, both constituents of ammonium carbonate, were not sought by flies, and it is concluded that the other constituent, ammonia, was the attracting agent.

The best results were obtained when water was added to the ammonium carbonate, because it prevented the deposit of a powdery layer of the less volatile ammonium acid carbonate which otherwise hindered the escape of ammonia.

The single ammonium hydroxide trap caught three female house flies during twenty-five hours' exposure.

Since the flies caught in the ammonium carbonate traps were largely females (90.7 per cent.), it was desired to know whether ammonia was particularly attractive to females, or whether females were unusually abundant in the vicinity of the experiments. Under ordinary conditions remote from breeding places the proportion of sexes in the house fly is about equal, with a slight excess of females.[4]

Accordingly, traps baited with food materials (milk, sweet soda water), were maintained in the vicinity of the ammonium carbonate experiments from July 21 to July 29. During this time 274 house flies were captured, 45.9 per cent. of which were males, and 54.0 per cent. females. In the same period, the ammonium carbonate traps caught 65 flies, 7.6 per cent. males and 89.2 per cent. females. Ammonia attracted a great preponderance of females.

Oviposition Experiments

Acidulated horse manure, timothy chaff, pine sawdust, and cotton were treated in such a way that they evolved ammonia. They were then exposed in a place frequented by flies, and after a period which varied from 3 to 99 hours in the individual experiments, counts were made of the egg-masses which had been deposited. Two or more eggs, placed together, were considered an egg-mass, but the large majority of clusters contained many more than two eggs. Occasional single eggs were ignored.

Oviposition in Acidulated Horse Manure.—The purpose of this series of experiments was to show whether fresh horse manure which did not volatilize ammonia would still induce the house fly to oviposit, and whether such manure, when again volatilizing ammonia, would attract the female fly. Fresh horse manure was treated with dilute hydrochloric acid so that

[4] Hewitt, "The House Fly (*Musca domestica* L.)," etc., Cambridge, England, 1914, p. 98.

the free ammonia was converted into ammonium chloride, an involatile salt at the ordinary temperature. The manure was left in a slightly acid state so that all the ammonia formed during the course of the experiments would immediately unite with the acid. It was tested with litmus paper for acidity before and after each experiment.

Porcelain evaporating dishes 120 mm. in diameter and 35 mm. deep were used as containers for the manure. Each was filled level full. The ammonium carbonate, when used, was imbedded in the manure; 57 grams was the amount generally employed. Ammonium hydroxide was not entirely satisfactory, because the ammonia escaped rapidly, and the addition of a liquid to the manure made it too wet. The controls held acidulated manure only, and were placed two, twenty-five, thirty or fifty feet from the acidulated manure which contained ammonium compounds. In one experiment the ammonium carbonate was placed in a glass dish to which water was added, and a dish containing acidulated manure was set at a distance of one foot on each side of it.

A summary of six experiments is given below. Each dish with its contents is spoken of as a lot:

Total egg-masses in 10 lots of HCl manure evolving ammonia from ammonium carbonate	164.0
Average per lot	16.4
Total egg-masses in 4 lots of HCl manure evolving ammonia from ammonium hydroxide	14.0
Average per lot	3.5
Total egg-masses in 10 lots of HCl manure separated 1–2 feet from ammoniated lots.	37.0
Average per lot	3.7
Total egg-masses in 10 lots of HCl manure separated 25, 30 and 50 feet from ammoniated lots	8.0
Average per lot	0.8

The lots which volatilized ammonia from ammonium carbonate were more than four times as attractive as the untreated acidulated lots placed near them (one to two feet), and more than twenty times as attractive as the acidulated lots placed some distance away (25 to 50 feet). In the single experiment in which an acidulated manure lot stood on each side of a dish containing ammonium carbonate and water, twelve egg-masses were deposited upon the acidulated manure, while none was found in the acidulated manure controls thirty feet distant. The oviposition response of the house fly in these experiments was roughly in an inverse ratio to the distance from the source of the ammonia.

Oviposition in Timothy Chaff and Pine Sawdust.—This series of experiments was conducted in the same manner as the acidulated manure series. The chaff and sawdust were always kept moist with water. The results are set forth in the following table:

Number	Material Used in Each Lot	Number of Lots	Distance from Ammoniated Lots	Duration of Experiments	Number of Egg-masses
1*a*	Timothy chaff and 241 gm. of ammonium carbonate	3		5 hours	19
b	Timothy chaff only	3	3 inches	5 hours	0
2*a*	Timothy chaff and 57 gm. of ammonium carbonate	1		17 hours	3
b	Timothy chaff only	1	2 feet	17 hours	0
c	Timothy chaff only	1	50 feet	17 hours	0
3*a*	Pine sawdust and 227 gm. of ammonium carbonate	3		99 hours	4
b	Pine sawdust only	3	12 inches	99 hours	0
4*a*	Pine sawdust and 106 gm. of ammonium carbonate	1		47 hours	2
b	Pine sawdust only	1	3 inches	47 hours	0

Timothy chaff which volatilized ammonia incited flies to oviposit on it within a short time. The average number of egg-masses per lot for the two experiments was 5.5, considerably lower than the average for the acidulated manure experiments. Larvæ were able to develop into normal flies in timothy chaff.

Pine sawdust was even less attractive than timothy chaff, with an average of 1.5 egg-masses per lot. Larvæ died soon after hatching in this substance.

Oviposition in Cotton and Filter Paper.—Pieces of ammonium carbonate were placed in evaporating dishes, covered with sterilized ab-

sorbent cotton, moistened with water, and exposed in a locality where flies were fairly abundant. Some of the dishes contained in addition small amounts of the following: ethyl alcoholic solution of skatol, ethyl alcoholic solution of indol, ethyl alcohol, phenol, valerianic acid, and butyric acid. In other dishes the ammonium carbonate was omitted, and the following compounds were added to the moistened cotton: ammonium sulphide solution, valerianic acid, and butyric acid. There were also controls of moistened cotton only.

For the filter paper experiments, the paper was torn into bits, moistened with water and placed over the ammonium carbonate. In one series the filter paper was stained with aqueous Bismarck brown.

Eleven experiments involving fifty-three individual lots showed positive results with only three combinations. These results are summarized below:

Material	Number of Experimental Dishes	Duration of Experiments	Number of Egg-masses Found
57 gm. ammonium carbonate + 2–5 c.c. valerianic acid + 50 c.c. water + cotton	7	3–72 hrs.	3
57 gm. ammonium carbonate + 2–5 c.c. butyric acid + 50 c.c. water + cotton	7	3–72 hrs.	18
57 gm. ammonium carbonate + 20–50 c.c. water + cotton	11	3–72 hrs.	1

Butyric acid, and to some extent, valerianic acid augmented the oviposition response of the house fly when added to moist ammoniated cotton. Ammonium carbonate and moist cotton without the aid of these acids brought forth almost no response.

Discussion

The small amount of oviposition in the distantly removed controls of the acidulated manure series was probably due to the fact that the flies were coaxed into the vicinity by the odor of ammonia from the ammoniated lots and came by chance to the distantly removed lots. These experiments show that many flies went a short distance from the exact source of the ammonia in order to place their eggs in a favorable substance and it is reasonable to expect a few would stray even farther. Of course a chemical substance present in the manure, but not tried in these experiments, may have been responsible for this slight attraction, or it may be true that an attractive odor is not always necessary to induce oviposition.

Female house flies have some power which enables them to discriminate between substances with high food value for their larvæ and substances which have little or no food value. This power is not infallible. Even when volatilizing ammonia, pine sawdust, cotton, or filter paper had little attraction, while acidulated horse manure and timothy chaff showed considerable attraction. It is suggested that this food-discriminating power is either a gustatory or a "contact-odor" perception.

Butyric and valerianic acids are found in barnyard manure, and it seems probable that their addition to ammoniated cotton gives to that substance an odor which simulates to a degree the odor arising from manure. If this is true it explains why house flies are readily attracted to ammoniated cotton to which these acids have been added. It is interesting to note that butyric and valerianic acids, when added in small amounts to ethyl alcohol, increased the attraction of the alcohol to *Drosophila ampelophila*.[5]

I hope to give these questions further attention. These studies emphasize the necessity for the proper disposal of all fermenting organic substances which volatilize ammonia, and reveal possible new angles of attack in the control of the house fly.

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[5] Barrows, William Morton, "The Reactions of the Pomace Fly, *Drosophila ampelophila* Loew. to Odorous Substances," *Jour. Exper. Zool.*, Vol. 4, pp. 515–537 (5 figs.).

SOCIETIES AND ACADEMIES

THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

ON March 8, 1916, at the American Museum of Natural History, New York, occurred the inauguration and first general meeting of a new biological organization, "The American Society of Ichthyologists and Herpetologists."

Officers were elected as follows:

President, Professor Bashford Dean.

Vice-presidents, Dr. Leonhard Stejneger, Dr. Barton W. Evermann, Dr. Charles R. Eastman.

Treasurer, Mr. Raymond L. Ditmars.

Secretary, Mr. John T. Nichols, American Museum of Natural History.

Publication Committee of Copeia, Messrs. J. T. Nichols, Henry W. Fowler and Dwight Franklin.

According to the by-laws adopted, the object of the society shall be to advance the science of fishes, batrachians and reptiles. Members shall be chosen from among persons interested in the subjects, and the business of the association shall be vested in the hands of a board of governors who are not to exceed fifty in number. Membership dues are two dollars a year, a certain proportion of the receipts being assigned to the support of the publication *Copeia,* which has been issued monthly since December, 1913, to advance the science of cold-blooded vertebrates.

The president of the society, Dr. Dean, presided at the morning and afternoon sessions of the public meeting, during the presentation of the following twenty-two papers:

"The Status and Needs of Our Study of Fishes," by Professor Bashford Dean.

"Origin of the Anura" (lantern slides), by Dr. W. K. Gregory.

"The Life-history and Habits of the Star-gazer, *Astroscopus*" (lantern slides), by Professor Ulric Dahlgren.

"Some Features of Ornamentation in the Cyprinodonts," by Mr. Henry W. Fowler.

"On the Discovery of the Great Lake Trout, *Cristivomer namaycush,* in the Pleistocene of the Middle West," by Dr. L. Hussakof.

"Hibernation and Food Supply," by Dr. W. H. Ballou.

"Some Life Habits of the Hog-nosed Snake" (lantern slides), by Mr. J. Fletcher Street.

"*Anomalops,* a New Genus," by Mr. C. F. Silvester.

"The Year's Herpetological Activity at the Museum of Comparative Zoology," by Mr. G. K. Noble.

"The Dean Bibliography of Fishes about to be published by the American Museum," by Dr. Charles R. Eastman.

"Development and Habits of *Ambystoma tigrinum* on Long Island" (lantern slides), by Mr. George P. Engelhardt.

"Some Congo Amphibians and Reptiles" (lantern slides), by Mr. James P. Chapin.

"Some Reptiles of the Colorado Desert, with Remarks on Their Associational Distribution and Environmental Relationships," by Mr. Charles L. Camp.

"Native Congo Fisheries" (lantern slides), by Mr. Herbert Lang.

"Collecting Amphibia and Reptiles in Florida," by Mr. Richard F. Deckert.

"Snakes of Santo Domingo" (lantern slides), by Mr. Clarence R. Halter.

"Collecting in Borneo" (lantern slides), by Mr. D. D. Streeter.

"Notes on Long Island Sharks," by Mr. J. T. Nichols and Mr. R. C. Murphy. (By title.)

"Albinism in the Western Gopher Snake," by Mr. Tracy I. Storer. (Read by Mr. C. L. Camp.)

"The Need of a Critical Study of the Squamation of Serpents," by Captain J. C. Thompson. (By title.)

"Conservation of Reptile Life," by Mr. P. D. R. Rüthling. (By title.)

"Reptiles and Amphibia Collected in the Painted Desert" (illustrated with specimens and photographs), by Mr. Dwight Franklin.

ROBERT C. MURPHY

THE INDIANA ACADEMY OF SCIENCE

THE Indiana Academy of Science met in Indianapolis, December 3–4, and presented the following papers:

President W. A. Cogshall's address on "The Origin of the Universe."

THE SYMPOSIUM ON HEREDITY

"A Résumé of the Work on Heredity," by Dr. F. Payne.

"Fifteen Years of Mendelism; Mendelism, the Key to the Architecture of the Germplasm," by Dr. Roscoe R. Hyde.

"Heredity in Man," by Dr. Charles B. Davenport.

"A Memoir of Donaldson Bodine," by H. W. Anderson.

"Memoir of Josiah T. Scovel," by Charles R. Dryer.

"Twelve of Nature's Beauty Spots in Indiana" (lantern), by Edward Barrett.

"Concerning the Report of the Survey of Lake Maxinkuckee," by Amos W. Butler.

"A Field Trip in General Science," by B. H. Schockel.

"The Tobacco Problem," by Robert Hessler.

"Histological Changes in Testes of Vasectomized Animals," by Burton D. Myers.

"The Minimum Lethal Infecting Dose of Trypanosomes," by C. A. Behrens.

"Tolerance of Soil Bacteria to Media Variations," by H. A. Noyes.

"Some Methods for the Study of Plastids in Higher Plants," by D. M. Mottier.

"The Morphology of *Riccia fluitans*," by Fred Donaghy.

"Plants not Hitherto Reported from Indiana," by Chas. C. Deam.

"Indiana Fungii," by J. M. Van Hook.

"The Second Blooming of *Magnolia soulangiana*," by D. M. Mottier.

"Additional Notes on Rate of Tree Growth," by Stanley Coulter.

"The Effect of Centrifugal Force on Plants," by F. M. Andrews.

"Some Preliminary Notes on the Stem Analyses of White Oak," by Burr N. Prentice.

"Botanic *vs.* Biologic Gardens" (illustrated by specimens), by Robert Hessler.

"Soluble Salts of Aluminum in Water from an Indiana Coal Mine," by S. D. Conner.

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"The Use of the Spectrophotometer in Chemical Analysis," by George Spitzer and D. C. Duncan.

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"The Lakes of the Tippecanoe Basin," by Will Scott.

A. J. Bigney,
Secretary (Retiring)

SCIENCE

FRIDAY, MAY 5, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE TRAINING OF CHEMISTS[1]

THE address of Dr. Whitney on research, which follows mine, deals with that aim of the chemist which always receives the most enthusiastic recognition, namely, the elaboration of the content of the science, the farther coordination of that content, and the expansion of the boundaries of chemistry. But thorough *training* is indispensable before original work can begin. A genius, without adequate training, seems to know by instinct what information he needs and where to find it. He devises new methods when those which he has learned fail. He reaches the goal, in spite of all handicaps. Better training would have saved him some needless loss of time, but often would not have improved the final result. Geniuses, however, are few and far between. The advancement of the science would be fitful if it depended upon them alone. The greater part of the additions to chemical knowledge are made by men with an aptitude for the science, it is true, but with nothing approaching genius of the higher order. With them, the thoroughness of the previous training is, therefore, a very potent factor. At the other extreme, in the case of the chemist who does mainly routine analyses, who corresponds to the draftsman as distinct from the architect, the training he received must determine largely the value of his results. In all the intermediate cases, where intelligent study of an individual situation is demanded, and new adaptations to special purposes are required, training in the prin-

[1] Address delivered in Urbana at the opening of the Chemical Laboratory of the University of Illinois, April 19, 1916.

ciples of the science and previous exercises in applying them to new cases, with the alertness and mental adaptability which such training produces, are the chief factors in success. The training of chemists is therefore a matter well worthy of careful study.

It is not my purpose to discuss the subject as a whole. I desire rather to emphasize four points which, after nearly thirty years' experience as a teacher, I am inclined to think are of vital importance, yet receive too little consideration, and indeed are often entirely ignored.

Overlapping Courses.—Take, for example, the treatment of the freshman who, on entering a college or university, offers chemistry for admission. In the vast majority of cases he is placed in the same class with those who have never studied the subject before. All agree that the result is unsatisfactory, but many attribute this result to the wrong cause. They say that the chemistry of the high school is valueless, and that their pupils would be better off without it. The actual fact is that to such pupils the introductory parts of the course seem trivial and boresome. They become indifferent. Later, when matter suited to more mature minds comes up, they do not observe the change. Soon they fall behind the beginners, and finally they barely pass in the course, if they pass at all. The result is not the fault of the student or of the high school, however—it is an inevitable result of ignoring the most familiar features of human psychology. Administer the admission requirement with reasonable strictness, place those credited with chemistry in a class or section *by themselves,* make them feel from the start that they are getting something that is new to them, and they will respond accordingly. Of course, elementary matters can not be omitted. No two members of the class come from the same school, their training is very diverse, and there is hardly one fact, no matter how simple, which is known to every one. The elements must be reviewed at the same time that new matters are introduced. But a pace much more rapid than that of the beginners can be maintained. In Chicago, my experience showed that this class secured in two quarters a much better knowledge of chemistry than a class of beginners could obtain, under the same conditions in three quarters.

If the school course is valueless, why give admission credit for it? If it represents a real advance into the science, as experience shows that it does, why ignore it? Why not accept it and start at the higher level? Overlapping of courses is all too common in chemical training, and it often begins by duplicating all the work of the high school, and not taking it for granted and proceeding beyond it.

Overlapping affects many of the later courses in every university. The instructor in qualitative analysis, instead of ascertaining exactly what is taught in the inorganic course preceding it, and confining himself to the briefest possible references to what he has a right to assume as known, too often spends many hours repeating such parts of the elementary facts and such elementary principles as are required in his work. I have known of instructors in quantitative analysis who ignored all the content of the previous instruction—both facts and theory—and reduced the subject to a series of mechanical processes, which could have been performed equally well (or equally badly) by a beginner. The students respond quickly to this situation, just as in other circumstances they would respond to demands on their previous training, and soon work with due lack of intelligence. Thus not only may the previous training remain unused, where continuous and most effec-

tive use could have been made of it and much might have been added, but, being unused, it is soon forgotten. At the end of two or three years of work, the pupil may actually know less of the science than he did at the end of the first year. Even if each course only overlaps about half of the preceding course, the inevitable result is that the pupil gains in four years only what, with better coordinated instruction, he could have secured in two years.

Curiously enough, the opposite fault affects much of our organic chemistry. Here the books, instead of striving to link the subject intimately with inorganic chemistry, and thus aiming at continuity, too often give the subject as far as possible the appearance of a different science. Unfortunately the instructors often follow the same lead. I have known cases where a law of chemistry was hardly ever mentioned, an experiment was never shown, a substance was almost never exhibited, and the only chemical material in evidence was pulverized gypsum in streaks and curves on a black background. There are notable exceptions, of course, but too much so-called organic chemistry is nothing but riot of symbols and "bonds." Some overlapping is necessary here, to offset the real differences in the nature of many of the reactions and of many of the experimental methods. The course might well be made essentially a part of the elementary general chemistry, and less like a separate science.

In respect to loss of time by overlapping, the university, with its numerous instructors, is at a disadvantage when compared with the college. In the latter, three or four years of chemistry are all given under the immediate direction of one man, and continuous work and rapid progress by the pupil are more likely to be secured.

Standard Courses.—In different institutions in which the training in chemistry serves the very same purposes, there is too little agreement in regard to the weight, the content, and the quality of the regular courses. In many universities and colleges, the course in inorganic chemistry based on high-school chemistry is standardized, and demands two or three classroom periods and six hours of laboratory work weekly for twenty-four to twenty-eight weeks. But the graduates of one large university tell me that their course in this subject is inferior in quality and extent to the average high-school course, and that previous work in the science is neither required for admission to it nor recognized in any way when existent. Courses of all kinds, intermediate between these extremes, are common. Now, the establishment of a more uniform standard is most desirable for many reasons. Migration from one school to another is rapidly increasing. Schools of medicine are requiring previous college work, but the boy who has had about half a course each in inorganic chemistry and qualitative analysis or organic chemistry can neither be admitted, nor can he be directed to any course in which his peculiar deficiencies can be made up. The student who decides to move to a school of engineering often finds that he has been provided with a similarly extensive, but superficial preparation which leaves him a misfit. When the student attempts graduate work in another institution, he encounters the same handicap. Of course, a slight course in inorganic chemistry can be followed only by a course in mechanical qualitative analysis, such as prevailed forty years ago, and any attempts in each successive course to develop a grasp of the modern aspects of the science must be given up. A separate and distinct course in physical chemistry, taken later, can never solve the problem. In such a course, only a few illustrations can be

given, whereas continuous application of the same principles in study and in the laboratory during the whole training is necessary to success. The student keeps the different courses in separate, watertight compartments in his mind, and only a genius will make the thoroughgoing applications and connections that are required to weld the whole into a science. Modern chemistry simply teems with applications of physical chemistry. This is the case both in the laboratory and in the factory, both in the biochemistry and physiology of the school of medicine and in the courses required of the student in chemistry and chemical engineering. The institutions of learning must respond to the obvious demand. We are not training students to use four or six years hence even the chemistry of to-day, much less the chemistry of 1880 or 1890. We are training them to understand the chemistry and biochemistry of the future and to apply and expand the science as it will be several years hence. All that we know for certain about that chemistry is that it will be less capable of mechanical, unintelligent use than the chemistry of the past, and that ability to apply theoretical conceptions will be more desirable, nay indispensable, than ever. Standardizing our elementary courses, both as to extent and as to character, is an essential part of preparedness to meet the demands of the future.

In this connection, a word in regard to the training of candidates for the degree of Doctor of Philosophy, a class of students which is rapidly increasing in numbers and importance, is in place. Their training in the fundamental branches of chemistry is at present very various and unequal in quality, even when sufficient in quantity. They can take advanced courses, but piling knowledge on a shaky foundation is unwise. The advanced principles can perhaps be used, albeit mechanically, when, as given, they happen exactly to fit the problem. But when they have to be adapted to a different situation, only a chemist who has an absolutely sound understanding of the fundamental elements of the science can make the adaptation with certainty. We are all familiar with published researches which were, in reality, futile and valueless because fundamental principles were overlooked, or were not correctly brought into relation to the observations.

One remedy is to require graduate students to attend the elementary classes. This, however, is only a half-measure. Review courses in general chemistry, analytical chemistry, and organic chemistry, in which these subjects are examined in retrospect, can be given so as to occupy less time, and yet achieve the object much more effectively. Emphasis can be laid on application of modern views, the oddities which pervade most courses in chemistry can be discussed, a broader and more critical scrutiny of the principles can be undertaken. Of especial importance is the fact that the classification of the content of chemistry can itself be discussed, although with beginners the classification can only be *used*. Also, the reasons for preferring certain definitions and certain conceptions can be considered, and less advantageous or even erroneous statements commonly encountered can be brought out as they could not be in a class for beginners. We learn much more by a study of wordings that are open to criticism than by simply memorizing uncritically faultless ways of stating the same things. Thus, the preparation of the graduate student can be standardized also, at least in respect to its most essential features.

An Alternative to Lecturing.—In a lecture, one states the facts or explanations clearly and, *for the moment,* the attentive

student understands perfectly. But, is it our object to train him to understand statements made by others—does ability to do that constitute a knowledge of chemistry, and play an important part in making a chemist? Is a watchmaker a person who recognizes a watch when he sees it, who knows what makes it run, and when it is running well, or is he a man who can make and repair a watch? Is not a chemist one who can himself make correct statements about chemical topics, and can himself put together the necessary facts and ideas, and himself reach a sound chemical conclusion? Listening to a lecture keeps the student in a *receptive* attitude of mind, whereas the attitude we desire to cultivate in him is the precise opposite of this. The student should begin by himself acquiring the ability to state simple ideas correctly, and later himself practise putting facts and ideas together and reaching conclusions. The conclusions are not new, but going through the operation of reaching them for himself is new to the student. No one would explain to a group of people who were not musicians how the piano is played, and perform a few lecture experiments on the piano, and then be foolish enough to expect the audience to be able at once to play the same pieces themselves. Of course not, because we all know that every kind of mechanical dexterity has to be acquired by practise and by the formation of habits, nervous and muscular. But we do not all realize that mental operations are also *largely mechanical*. For the most part they are made up of half-unconscious responses, each of which is an idea previously acquired by practise, and only the selection of the units of which the whole mental operation consists and the arranging of them in due order are the results of actual thought and conscious reasoning. After explaining some point to the class, such as the reasons in terms of the ion-product constant for the precipitation of calcium oxalate, one might assume that they all understood the explanation, and perhaps they all do. But ask them individually to *state* briefly the reason for the precipitation, and some will make remarks that have no bearing on the subject, some will make partly incorrect statements, many will make statements that are correct so far as they go, but are incomplete. Only one student in thirty will give a correct and complete answer. Many of the others undoubtedly understand the matter perfectly, but unless they have an opportunity themselves to put the answer together, the impression will be slight and fleeting. It is the exercise of going through the reasoning and the wording of the answer, for oneself, that alone can make the impression a permanent one and fix the explanation in the mind.

Evidently, the pupil would better study the subject in the book, taking much or little time according as his powers of acquisition are slow or fast, until he can state each important point in his own words. Then the class-room work can be confined to testing the preparation, discussing difficulties, showing illustrative experiments, and asking questions about the cases illustrated. Before printing was invented, oral instruction was necessary. It seems to me that a good many university men have not yet realized that the printing press is now available. It is right that we should know the history of our profession, but not necessary to adhere to all the practises of antiquity. We all know walking was invented before the locomotive, but none of us walked to Urbana to this meeting. Was that thoroughly consistent?

I am not proposing to abolish lecturing. In courses taken by students who already know how to study, that is, in the more

advanced courses, lectures are of great value. They give a general view of the territory as a whole, they distinguish the more important from the less important items, and they enable the student to conduct his *own private study* of the subject with intelligence. I am referring mainly to the elementary course for freshmen, where not one member of the class in twenty has ever studied in the true sense, or has any knowledge of how to study. It is a part of the benefit he gets from the course that he learns how to study and acquires the necessary habits. Listening to lectures, in such a case, if the lectures are well constructed, only deludes him into thinking that he has fully grasped the subject, and *prevents* him from studying. Additional class-exercises given by assistants and subordinate instructors do not help the situation materially. Often the assistants do not keep in close touch with the mode of presentation of the lecturer. Always the students feel that, since assistants handle this work, it must be less important, and so it suffers in effectiveness. After trying both plans, it will be found that incomparably better results are obtained by giving two or more sections, of thirty to forty students each, to a competent instructor, and letting him conduct the whole work of each section. The lessons are assigned in advance, and due preparation is insisted upon.

There are other disadvantages of the lecture method for freshmen. The lecturer must adjust his speed to that of the slower, if not the very slowest members of the class, although many of its members could follow equally well if the pace were tripled. With the slower students spending more time in preparation, and this and the other variable factors thus relegated to the home study, the class becomes more uniform, and either twice as much ground can be covered in the hour, or the ground can be covered twice as thoroughly, according to the nature of the topic.

That the student has thus acquired a more thorough foundation in chemistry, and that he has learned how to study, are both of great advantage when the next course is taken. When the lecture method has been used, the students have still to be taught the necessity for continuous study and how to do it, and progress in the next course is slow. Then also, the fleeting impressions, detained temporarily by a few days of violent but superficial study just before the examination, have almost entirely evaporated, and overlapping and repetition of all the necessary facts and principles is an absolute necessity. For this reason, also, much time is lost. Efficiency demands that something of permanent value be accomplished *each year*, and there is every reason against postponing the application of efficient methods to the second year.

Again, questioning shows at once which points have been understood by all, and which points have remained unclear, and the time is spent on the latter. Also, the recollection of past topics, when the need of applying them arises, can be tested, misunderstandings can be recognized and removed, and lapses of memory can be remedied. The method finds out infallibly what is needed, and how much in each case is needed, and permits the doing of precisely what is necessary. The process involves continual measurement of the existing results. A lecturer can only guess at what is needed, and how much of it, and must necessarily be more or less in error on every occasion. The method advocated has for the chemist the attraction of being quantitative and, with practise, the experimental error becomes negligible.

Still again, since the lectures are sys-

tematic and orderly, while the laboratory work is necessarily more or less topical, the pupil thinks the lectures are the real kernel of the course. Yet, in point of fact, the real contact with the subject takes place in the laboratory, and it is better therefore to make the student feel that the laboratory work is the principal feature of the course, and that the class-room work is simply a discussion and adjustment of what he has learned in the laboratory and at home. Individual observation and reasoning from observation, can thus receive that strong emphasis which they deserve, but in a lecture can never receive. Naturally, every week each student must begin with the experiments for that week, since he can not otherwise prepare himself for the class meetings.

Finally, many chemists admit that they learned little chemistry from the first lecture course, but insist that the personality and point of view of the lecturer—not only in matters chemical, but in respects quite remote from that science—exercised a profound influence upon their own point of view and their subsequent attitude towards life. In reply, it need only be pointed out that, in the free interchange of thought which is a necessary part of the method suggested, the opportunity for the personality of the instructor to assert itself is even freer than it ever can be in a lecture, and that the digressions, if they are such, since they will usually be suggested by reactions shown by the students themselves, will be much more likely to strike some target effectively and forcefully than will the random shots of a lecturer, who knows only what is in his own mind, and nothing of what is in the mind of the listener.

Improved Laboratory Facilities.—The mechanical equipment of a chemical laboratory is an important efficiency factor in the training of chemists. There is perhaps no department in the college or university where the ratio of results achieved to time spent is so small. This is particularly true of the quantitative and organic laboratories, although it is conspicuous in all branches of the science.

For example, the evaporation of a solution on a steam bath may take five or six hours. The temperature of the liquid may never greatly exceed 90°. A vigorous attempt is made to train the student to carry on several operations simultaneously, but four or five months elapse before he learns to do this effectively. A plate covered with shot and heated with steam under pressure, one at each working place, will easily give a temperature of 130°. The time required for the evaporation will become a mere fraction of that required with an ordinary steam bath, and the saving of time will begin on the first day, instead of being postponed until months of training have brought about the same result by another method. The cost of fuel will also be less. When the dissolved substance is a very soluble one, the vapor pressure of the solvent becomes rapidly smaller as evaporation proceeds, and soon the steam escaping from a bath gives to the air a partial pressure of water vapor equal to the vapor pressure of the solution, and evaporation ceases. With the steam confined in the plate, so that saturation of the air is avoided, the evaporation will proceed much further without interruption. A tube connected with a vacuum system, provided on all desks, will remove the vapor, and will facilitate further evaporation beyond this point to a surprising degree. Desk ventilation is of course required when the steam plate is used.

Ventilation at each working place, as it has been installed in the new laboratory here, also permits much saving of time. Hoods take the student away from his desk

and reduce the number of operations he can carry on simultaneously. Hoods become dirty and unsightly, because no one student can be held responsible for their condition. They also furnish the students with an excuse for leaving their desks, and conversing about football, when they should be at work. In case a hood is really required, which seldom happens, a folding hood can be drawn from the supply-room and erected over the desk ventilator.

The traditional arrangement of chemicals on a side shelf is also open to many objections. Anywhere from ten to a thousand times as much of the chemical may be taken as the operation really requires, so that reckless habits are acquired and much material is wasted. When the class is following a program, and working on the same experiments, the same chemical is needed by several students at the same moment, and delays occur. For the same reason, certain bottles are quickly emptied. When one of the bottles is empty, it is not the business of any student to have it filled, and so another convenient excuse for conversation is provided. The side shelf furnishes opportunities for conversation far more plentifully than it does chemicals. With a little initial work by the instructor, a list of the amounts of each chemical and solution required for the term's work can be prepared, and each student can be provided with a kit of chemicals which he keeps in his desk. Professors Freas and Beans tried this plan first on a class in qualitative analysis, and the instructor added between twenty and twenty-five per cent. to the work of the course in order that the time thus saved might be utilized. The saving in the total quantity of chemicals consumed pays the expense of making up the kits, and the twenty to twenty-five per cent. additional training is all clear profit. Every student is entitled to the set of chemicals appropriate to his course. If he wishes to use more than the allowance, which should be ample, he can obtain them from the supply room and have them charged in his bill for breakage. Thus those who prefer to be extravagant pay personally for the privilege, and the appropriations at the disposal of the department are conserved and permit the offering of better facilities to all.

For example, in one term of a course in organic chemistry, one student used less than $8 worth of chemicals, while the largest amount used was over $28 for the performance of the same work. It was evident from this that $12 worth of chemicals was ample, and that all students using more had been dissipating the resources of the department, and should hereafter be required to pay for the excess.

In a large laboratory, there are times of the day when the number of students trying to replace broken articles or to obtain other supplies at the stock room becomes great, and loss of time is the inevitable result. No institution of learning can afford to multiply skilled attendants, when they are needed only during a rush hour in the afternoon. On the other hand, the use of unskilled help leads to mistakes, involving loss of money by the department and loss of time by the student. The provision of more than one supply-room is an expensive remedy, and does not always prevent crowding. Instead of waiting twenty minutes or more for his turn, the student can in one minute write out his demand on the telautograph, and then return to his desk and go on with his work. A receiving clerk stamps the card in a calculagraph clock at the time the order comes in, and again when the boy returns after delivering the article and presents the same card signed by the student. The time required for filling the order need never exceed seven minutes: if

it does, the cause of the delay is investigated. Of course, a stock of supplies equal to all ordinary demands must be available, and in the larger laboratories this stock represents an investment of at least sixty to eighty thousand dollars.

In all laboratories, much glass apparatus is returned in dirty condition. Since it will not be accepted in this condition by another student, it can not be received. It is thrown away and the student's account is charged with its value. Installing dish-washing machinery will save the greater part of this expense and reduce materially the number of new articles to be ordered, received, unpacked, checked, and stored. In our own experience the substitution of a charge for washing, in place of a charge for the whole cost of the apparatus thrown away because of being dirty, as it had been made the year before, reduced the breakage bills for an equal number of students by nearly $1,200. During the year the apparatus of instructors and the apparatus used in lectures can be washed at one central place more economically than by scattered, unsupervised labor. Then too, in many courses, cleaning apparatus takes up much of the time of the student. A graduate student, who is paying tuition, room-rent, board and other living expenses, and who is sacrificing his earning power to obtain further education, can save time which has a high money value to him by sending his apparatus to the supply-room for cleaning.

Ring-stands and burners are usually painted with asphalt paint. This gives an exceptionally porous covering, especially fitted to permit access of laboratory gases and to hold moisture. One investigator finds that when more than two coats of paint have been applied, rusting is not retarded but accelerated. The sand blast will take off every trace of the paint with astonishing ease and thus, with a single coat of new paint, of a properly chosen kind, every article placed in the outfit will look as good as new. Ill-kept apparatus fosters careless work, while nice-looking apparatus guides the student, without his being conscious of the influence, into clean-cut and satisfactory manipulation.

The sand-blast reminds us that a mechanic and a workshop are necessary features of a large laboratory. One recent research by an eminent chemist indicated that he made an electroscope out of a tomato can tied to an empty Lydia E. Pinkham medicine box by means of tan-colored shoe laces of the latest model. A more efficient and durable instrument could have been made with the help of a mechanic, and much of the time the professor and student spent in trying to work with this aggregation would have been saved. It is more economical to purchase standard apparatus, but, when modified forms are required, when repairs are needed, and when new apparatus is devised for research, the mechanic, readily accessible in the building, is a necessity.

Another problem of the laboratory is to utilize the desk space during a larger proportion of the time. If many of the desks are to be used during only two afternoons in the week, and are to remain idle during four fifths of the working hours, one can not provide a desk for each student, with all the overhead cost for the building and plumbing which that implies. In some courses, three or four cupboards, each capable of holding the whole outfit, can be provided under each working space, and three or four students can be accommodated. But in many cases, as in quantitative analysis and organic chemistry, the outfit is extensive, and often only one student can use the desk. Yet the space is not really utilized. Most of the apparatus is placed on

the bottom of the cupboard and on the single shelf above—with the smaller articles in the drawers—and much empty space is provided above the apparatus, in order that articles at the back may be taken out without disturbing those in front. Can not some way be devised of saving this space, and at the same time making it unnecessary for the student to get down on his hands and knees on the floor to explore the dark recesses of the desk?

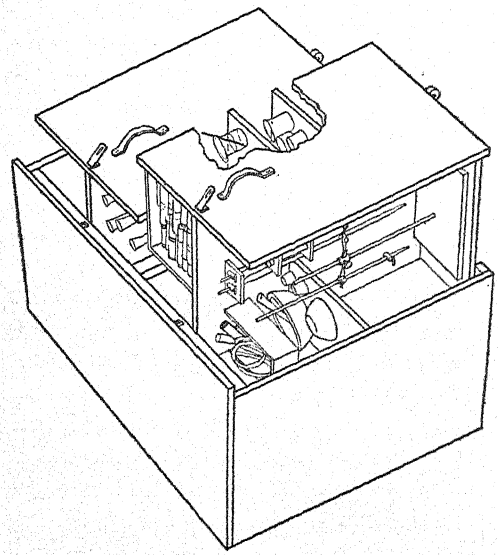

Fig. 1.

A desk designed by Dr. Fales seems to solve this problem (Fig. 1). The door is without hinges, and is pulled straight forward. Attached to it is a set of shelves and racks of the same width as the door, and extending to the back of the cupboard. These are planned so as to provide a place for each item in the outfit. This moves on a small wheel in the center of the foot of the door, and is supported behind by a wheel running in a brass-lined groove. Thus, when the front panel (or door) is pulled out, the whole rack comes out into the light, each side can be examined at a glance, and any article on it can be taken out in an instant. The outfit, placed in the box in which it is drawn from the supply-room, occupies 10,000 cubic inches. When set out in the rack, it occupies 24,000 cubic inches. When placed in the ordinary desk, with its cupboard and drawers, it occupies 44,000 cubic inches. Since in the rack-cupboard it thus occupies only about half the space commonly required, two outfits for two different students can go where one went before. In addition, actual measurement shows that the student can take out any needed article or chemical in one third of the time required with the common arrangement, and instead of taking 3–4 minutes (by measurement with a stop-watch) to ascertain that he does *not* have a chemical asked for by the instructor, he reaches the same conclusion with greater certainty in six seconds. The effort to pull out an ordinary laboratory drawer, when empty, requires by measurement, a force of four to twelve pounds. That necessary to draw forth the rack with its complete load of apparatus and chemicals (weighing 40 lbs.) is only two pounds. And finally, the construction of the desk costs no more than does that of the usual desk with two drawers and a cupboard.

There are teachers of chemistry who feel that mechanical devices for making laboratory work more efficient are beneath their notice. But, after all, the laboratory is essentially a study in which materials take the place of books, and manipulation and thinking take the place of reading and thinking. A book is arranged mechanically for convenient and rapid use, whether it is to be read straight through or employed for reference. Why should not similar attention be given to the mechanical arrangement of the laboratory? Of course, the publisher and printer arrange the book—not the author. But the architect does not know enough about chemical work to devise anything helpful—and we are lucky when he does not knock out part of our plans by

persuading the authorities that they will put the building out of harmony with the other structures on the campus. Hence the chemist must himself tackle the problem in detail. Then again, if the laboratory operations occupy long periods of time, the intervals between the points at which thought by the student is required, or the practise of certain manipulations is demanded, are so prolonged that the pupil forgets to think when the time comes, and bungles the manipulation because his mind has long since wandered to some other subject. Thought and physical activity are more effective when there is a more or less continuous demand for them, and so every abbreviation of the periods of waiting and of the interruptions, caused by looking for some article or going to a hood, increases the efficiency of the work as a form of study. It also, of course, permits more work to be done, and therefore more subjects for thought and more manipulation to be introduced, and so gives more mental training and greater technical skill.

The magnificent addition to this laboratory, the opening of which we are now celebrating, has been made at a most opportune time. A German statistician has discovered that the ratio of chemists to population in four countries is represented by the numbers: Switzerland 300, Germany 250, France 7, Great Britain 6. The corresponding number for the United States is probably nearer to the two last numbers than to the number for Switzerland. The general run of people in this country, even educated and intelligent people, have hitherto been almost entirely unaware of the important rôle which chemistry plays in the industries. When you tell them that many railroads employ fifteen or twenty chemists each, they stare in astonishment, and can not imagine what there is for a chemist to do in such a connection. But the discussion raised by the war has suddenly drawn chemistry out of its modest retirement, placed it in the limelight, and advertised it as nothing else could have done. The number of students in chemistry, always a rapidly growing factor, has this year taken a great leap forward. The University of Illinois is fortunate in having completed a building for chemistry so carefully planned and so magnificently equipped. It is fortunate also in the splendid spirit which has characterized its work in chemistry, and in the remarkable number of investigations of the highest order which have been, and are being carried on in its laboratory. The state of Illinois is to be most heartily congratulated both on the performance of its university, along chemical lines, in the past and, with the space and the facilities which the new laboratory offers, upon its promise of even greater things in the future.

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COLUMBIA UNIVERSITY

RESEARCH AS A NATIONAL DUTY

THE object of this paper is to emphasize the importance of material research and to lay stress on its necessity to any people who are ever to become a leading nation or a world power.

I have called it material research because I wanted to exclude immaterial research. I class under this head pure thought as distinct from thought mixed with matter. It is worth while making this distinction because, from the youngest to the oldest chemist, it is not always recognized. It is very natural for us to think we can think new things into being. Chemistry has advanced only in proportion to the handling of chemical substances by some one. When the study of our science was largely mental speculation, and the products and reagents largely immaterial,

like fire and phlogiston, we advanced but slowly. Ages of immaterial research for the philosopher's stone only led to disappointment. Successful results in modern times came from following nature, learning by asking and experimenting, reasoning just enough from one stage of acquired knowledge to ask the next question of materials.

Professor Trowbridge, of Harvard, once said:

> Before Galvani's time men were lost in philosophical speculations in regard to subtile fluids; after his experiments their thoughts were directed to the conditions of matter immediately about them. Benjamin Franklin brought electricity down to earth from the clouds, while Galvini's experiments brought men's minds down from the heights where they were lost, having no tangible transformations to study.

I will go directly to my point. We are being shown by systems of national development how important is the study of the properties of matter. There is no need to raise the questions of the war, nor of the relative originality of different races, nor to compare the gifts to scientific knowledge of the various world powers. We will go only so far as to point out that in national processes there may be a certain peculiar and useful attitude towards exact knowledge. I mean by peculiar that, as is the case of Germany, it differs in direction and intensity from that of other countries. In so far as it is useful, I want to recommend it. We all condemn it where it is abused. I want to convince you, if I can, that in the uses of science we ourselves have much to learn, and in the matter of research we are still children.

In speaking of research, I do not mean to confine my thoughts to the chemists and their knowledge and literature, but rather to that science which is back of chemistry. We may call it natural science, if we are careful. It includes, for my present purposes, all philosophy based on measurable facts. Psychology and therapeutics come under this head; so do electricity and medicine, anatomy and physics, chemistry and biology. These are inquisitive sciences, where the answers come from asking questions of nature. If I can leave with you even a faint impression of the importance of new knowledge, the strength to be gained from its acquirement, and the pleasure in the process itself, I shall feel repaid.

Research is sometimes looked upon as a remote, postponable, and especially exacting undertaking, well suited for martyrs of science and unreasoning optimists, and not at all for teachers. The historical methods of teaching have still lingering in them some of these signs. Even in our day it is sometimes said that a teacher should not be an investigator. It will take a long time to completely efface that idea, but it will be as surely forgotten as the fact that most of our older colleges were once religious centers. It is important to realize that the need, facilities and possibilities of research are all about us, retarded only by the inertia that is in us. So much useful pioneer work in all fields has been done with simple material equipment coupled with good mental equipment, that it almost seems as though this was the rule. The telegraph and telephone started with a few little pieces of wire wound by hand with paper insulation. The basic work on heredity was carried out by an Austrian monk with a few garden peas. The steam-engine came from the kitchen fire, and wireless from the tricks of a little spark gap. There was, however, the same general kind of mind behind each one of these discoveries, the mind of the trained inquirer.

Exactly the opposite belief is also quite

common—that great advances are made by sudden flashes of thought through the mind of some lucky and presumably unoccupied individual. If this were so, there would be little need for the high degree of training which is necessary for almost any scientific service in our day. We may find a simple illustration of this point in organic chemistry. We know that the artificial production of important chemical compounds, such as indigo and rubber, has been accomplished. But how many of us even begin to realize the training that was necessary and the research that had to be done before success could be claimed. The Badische Company spent seventeen years completing the indigo work after the first synthesis, and expended about five million dollars before a pound was put on the market. I might say that without at least fifty years of work by thousands of research chemists, neither problem could have been solved.

I would also be right in saying that if you removed from that structure even a part of the purely theoretical work, such as that where organic chemists spent their lifetimes testing the compounds for the imaginary double bonds of the hypothetical benzol ring, such synthesis would not have been brought about.

In my study I have a photograph of about thirty young research men grouped about Wöhler. This is the chemist of Göttingen who first discovered that an organic compound could be produced in a laboratory. It was he who also made the first metallic aluminum. The picture was taken in 1856, about as early as decent photographs were possible. Every year since 1856 that Göttingen laboratory, among others, has been training chemists in research. They have gone into fields of infinite chemical variety. Each man has been a center in some distant place, and around this center there has often been built up in turn some kind of chemical structure. Many became teachers, and their students in turn became experimenters and teachers. Many followed industrial chemistry and extended the field of the ever-increasing army of chemists. In my particular photograph is one man who in 1866 became the Professor Goessman of the Rensselaer Polytechnic Institute and was later professor at Amherst and very prominent for years in the Massachusetts State Board of Agriculture.

Since 1856 the same seeking for knowledge by renewed groups of such men has been continually going on in many foreign laboratories, but is only slowly being taken up in our country. Is it not time that we awakened to the fact that, as research chemists, we are still in our infancy? If we are ever to be a leading country in industrial chemistry, research is absolutely necessary. If such research is done elsewhere, then the major part of the advantage will lie elsewhere also.

This is one of the most difficult points for an American to recognize. Forests may be leveled by a brawny arm with an ax, canals may be dug with a dredge, but practical science needs knowledge and training, and always more training.

Scientific research, or research in the natural sciences and in the industries, might be defined as the pioneer work of the developed country. In this light it is easy to see that our turn has come. Not long ago our pioneer work was of another kind. It was opening up the undeveloped land. It was actively and well done. But the work must change because our requirements have altered.

Carl Helffereich, director of the Deutsche Bank and now secretary of the treasury of Germany, writing before the war, said:

All economic labor aims at making external nature contribute to the needs of man. It is as true of the primitive gathering of roots and berries as of the production of cyanamid or calcium nitrate. The enormous progress of modern economic technique is due to the splendid development of the natural sciences and the systematic application of scientific knowledge to economic labor. Physics, chemistry and electricity have outvied each other in their influence upon economic technique.

Speaking of the scientists, he says:

Our hermit poets and thinkers converted themselves more and more during the past century into practical creative workers, and an enormous expansion of activity has resulted from the progress of the pure and applied natural sciences.

American chemists have had German chemists pointed to as examples almost long enough, but there is some value in concrete examples, and I can not refrain from comparing our own impoverished condition in the matter of nitrogen to that of Germany.

Excepting one or two minor attempts, we Americans have made almost no study of the fixation of atmospheric nitrogen. I want you to realize the varied and expensive researches, mostly carried on abroad, which were required to reach the present position of the nitrogen question. There were in Germany and, by German capital, in Scandinavia, several direct oxidation processes, carried through the experimental to the practical commercial stage. The Schoenherr process is one of these, the Birkeland and Eyde process another. The direct combination of nitrogen and hydrogen to form ammonia has been successfully developed in the German Haber process, and the cyanamid process, with all its products from carbide to ammonium nitrate, was developed in Germany. There they used not only the peculiar reactions of calcium carbide with nitrogen, but the production of the nitrogen from liquid air, the reaction between water and cyanamid to form ammonia, and then an oxidation process for obtaining the nitric acid. The oxidation of ammonia to nitric acid by such methods as the Ostwald process has been studied by many investigators since 1830, and several different schemes are now in use abroad.

At the time most of this research work was under way it was not at all clear what use was to be made of it. Much of it was purely academic research, but it was clear that without the knowledge itself certainly no use at all would be made of it.

I do not want you to look at research as an old, established utility. I want you to see it as I do: a powerful factor proved in the advance of the industrial welfare of the foremost countries, and a world-experiment of less than a century's trial, but something still unappreciated in America. It is true that the earliest man and many of the lower animals accomplished ends by research, but I refer now to research in the natural sciences and to the research which in our day is necessary to our desired activities. These sciences are already very highly developed, and an equally advanced education is demanded. For example, if I wish to cure physical ills, I can not expect to do it by reciting ancient incantations, nor by using roots and herbs, as was once customary. I must first familiarize myself with an accumulation of previous experience. I must study anatomy, physiology, chemistry, bacteriology, etc. This is a relatively recent world-condition. Conditions are similar in all the applied sciences. The accumulated knowledge in any field is already very considerable, and to get on to the firing-line of useful work one must go up past the baggage-train of knowledge and experience. There is something in the blood which makes an American naturally hate preliminaries. It will be a great day when we see how important

preliminaries are. The hospital surgeon well knows how much more willing the young interne is to actually handle cases, if it is only to administer the ether or the iodine, which any nurse can do, than he is to study the theory of ether as an anesthetic, or of iodine as an antiseptic, which perhaps no nurse could understand. The young student of mechanics thinks he could have devised the steam turbine if it had not been done before his day, but when he comes to study the problem as it has actually been developed, he finds the same old kinetic theories, differentials and integrations which he spurned as too theoretical when he sought a short road to engineering.

I want you to realize that in America we are going ahead in future at a rate dependent entirely upon our preparation. Laboratories are a relatively modern thing. In most of the sciences they are a development within the lives of men now living. I want you to see that we must be foremost in systematic, organized research, or we will be distanced by other countries which already well recognize the value of new knowledge.

When so much of our material welfare, the condition and extent of our manufactures, the quality of our agricultural efforts, and the health of our people, depend upon the rate of our acquirement of new knowledge, there ought to be much greater effort made along the lines of research than is at present the case.

We call knowledge power, but we need to see that new knowledge is like a second power to power.

I'd rather be a little Moses than a big Jeremiah. I'd rather point a way to a promised land, however remote, than talk about our lamentable conditions. But we Americans are not entirely imbued with the spirit of active and efficient service. We are a preliminary experiment on the possibility of operating a competitive nation in a democratic manner; but we don't care much about it. We have about as little interest in the wonder and elasticity of nature, the laws of materials (except where they affect our stomachs and our health) as had Darwin's starving Patagonians. With us the spirit of the hive is confined to the bees. Germans and Japs make better scholars than we do, and a Chinese laundryman sticks longer to his daily job and talks less about it. We are living in the Garden of the Gods, but we are still eating grass.

Is there no significance in the fact that many of our colleges are better known through their foot work than their head work? Is it not significant that the Y. M. C. A.'s dotting our land are as strong in bowling-alleys as in education, and that most of our religious training goes to the heathen? Is it a sign of health that so large a portion of our newspapers are paid to feed us with results of useless experiments between prize-fighters? I think the stadium should be the accessory of the laboratory, not the temple of the oracle; and that in reality a research laboratory is more compatible with the object of a university than is the more common training-table. I do not mean to be too insistent as a critic or too pressing as an advocate, but I hate to see my own country such a trailer as it now is. I hope the conditions are changing, but I know they are not changing fast enough.

All service is based on knowledge, and knowledge is an ever augmenting thing which almost any one may increase. If the stock is *eternally* useful as it is, how great must be the value of the indestructible increments which any one may produce. I do not think due reverence is given to new knowledge. I want to illustrate.

Some time, somewhere, centuries ago, the slag of a fireside appeared transparent,

some one tried to learn more about it, and so, ultimately, glass was made. Research is still under way on that very material, and countless numbers of men have added to the knowledge. Glass has kept the cold from the house. It has let in the light. It has renewed our eyes as they have worn out. Through telescope and microscope it has shown us the greatest and the smallest things of the universe. It has bottled our drinks and held our lights. Every year still adds new service, just in proportion as experiments add new knowledge of glass. To-day we hear of new glass permeable to ultra-violet light, glass opaque to X-rays, and glass for cooking utensils. Not one of these little increments will ever be lost, but will continue in use, so how highly should we value them? Why did we delay so long in coming thus far, and how far or fast may we still go?

Research is preparation. It is preparing in our decade for the problems and the necessary work of the next. There are various kind of preparedness. We are hearing a great deal about one of them nowadays—immediate preparedness for national defense. But there is a more far-sighted preparedness that no one has adequately described and of which the building of new laboratories is a sign. This type is the very best kind of preparedness for national defense, if begun in time. The continued study of the secrets of nature, the uncovering of buried treasures which always seem buried just deeply enough to develop the digger—these are the criteria of a strengthening nation.

Research presents a way, and the only certain one, of insuring peace, of preparing successfully for defense, and of being successful in war. It is the lasting, undeviating factor which has always dominated. This may sound bold and entirely inconsistent in itself. It is all true. Can we learn to see it? From the military expert to the anthropologist, thinking men recognize that for over 100,000 years war has been almost continuous on the earth. The inventors of chipped flint successfully fought those inferiors who had not experimented with flint. There were then no better arms. These also got their game even when it was scarce and other means failed, and so they continued to survive. This little and early example of survival was repeated a great many times before our present complex world conditions were reached, and will as surely continue to be repeated. The fundamentals were always the same. A 42 cm. gun is only a better flint. Trinitrotoluol is only a more modern sling. Arms and ammunition have changed, but just so have also changed the myriads of other important accessories to survival. This is the important point. Good guns go with good clothes, and niter is used both in fertilizers and in guncotton. The signs that we are improving in our civilization will also indicate that we are growing in our powers of national defense, but this should come rather as a consequence than as an object. And we Americans must not stand still. The world has always been improving, and the real growth and development has come to those nations which have been responsible for the original research work and not for the mere storage or conservation of the knowledge.

The first or fundamental discovery in any series is not the only important one, so I am going to take an extreme view and say it is only the continuation of research which is of any considerable importance to us. The fundamental discoveries may be like seeds, but the values are like growing plants. An acorn may correspond to the work of a Henry or a Faraday, but the great and growing tree of electrical or chemical work corresponds more nearly to

the living state of the oak species. We are much more interested in what is to come than in what has already been accomplished.

I realize that I ought to illustrate this appeal for research by concrete examples of things to discover. I know the feeling of the chemist who is mentally compressed by the mass of investigation work which has already been done and by the known facts which seem already to entirely cover all possibilities; but I know, too, that the future will make use of knowledge for which we now have no vocabulary and no powers for comprehension, and so could not possibly anticipate. If, then, I try to illustrate the search for new knowledge, you may be sure my illustrations will be inadequate.

In the first place, I can not be reckless enough. This I learn from looking backward. I would not have dared suggest that a dozen good men should study the little hydrogen generator of the freshman laboratory, to see what was in it. If I had, I suppose I should have suggested a research on pipe organs, because of the singing hydrogen flame, or on bombs, because of its explosion. But some one tried synthetic ammonia, others Zeppelins, and others the cutting and welding of iron. When I see in our factory the three score men now using oxhydrogen all day for this latter use, I am impressed with the eternal proximity of new and useful knowledge. A very few years ago, two or three times as many men would have been necessary to do this work in the old more difficult and less satisfactory manner.

The most natural suggestions for research are those simple ones referring to chemical elements. There are still plenty of unknowns among the elements, and of one thing we may be sure, there are certainly no two alike. Any chemist who wants to add to chemical knowledge need not go beyond the list of elements for his subject. The properties he discloses will every one of them be sometime a help to his science and of service to his country. As far as possible, his country will reward him with patents if he asks them.

We ought to begin at the points where others left off, and continue the research of the chemical elements. One reason why this appeals to me is that I have seen so many recent applications of entirely new knowledge of elements in my own work. I will just mention tungsten, molybdenum, boron, argon, silicon, magnesium, titanium, thallium, vanadium and chromium, which, because of properties not known until recently, are nevertheless already doing commercial service in our restricted electrical field. Surely we know still far too little about these elements, but we know less about some others.

If now the chemist, still forgetting the compounds and narrowed in his researches to the elements, and then perhaps to the metals, and finally to a single element, still asks, what shall I do? I would refer him to the isotopes of his element. Our American Richards, supporting the researches resulting from the studies of radioactivity, has shown that there are two leads. They are somewhat different, but can not be separated easily. Of course some one ought to separate all isotopes, and then there is plenty of room for research on the single isotope.

One of the great needs of the country which reflects on us chemists and calls for immediate research is that for American potash. There is no supply in sight which is nearly comparable with the German deposits, and our fertilizer and other industries will certainly suffer because of this deficiency. We have plenty of feldspar calling for a simple process for removing

the potash it contains. We have oceans of sea water carrying plenty of potash, if we knew how to extract it. Don't say it can't be done, for it is already done by miles of seaweed. Why should we confine ourselves to trying to take it away from the seaweed, instead of learning what the seaweed knows about getting it from the water? You will look supercilious, but until a large number of chemists have studied semipermeable membranes, there will always be this lack of understanding of those simple reactions of living matter going on around us. There will always seem to me a possibility of doing such physical and chemical processes more nearly as we may wish to do them when we know how these operate.

When nothing new is being done by us it will be a sure token of our decay. When we stop increasing our experimental activities or fall for a considerable time behind the activities of other countries, we may expect to see our light become merely a memory, like that of Greece or Rome. Thus far we Americans have not reached a fair average as investigators in natural sciences, and yet we have incomparably superior conditions for the growth of research. I can not look beyond the period when research shall cease in a country and still imagine that country a power in the world.

There are no sharp lines to be drawn through research to separate pure from applied, scientific from practical, useful from useless. If one attempts to divide past research in such a manner, he finds that time entirely rubs out his lines of demarcation. At this particular time, however, one may imagine a more or less zigzag zone which serves to divide research in a commonly accepted way.

In a manufactory the price of a new product should include the cost of research. No matter how complicated the system, this is always true. Otherwise the industry would ultimately commit suicide. In practise it is common to apportion to particular products the cost of their separate development, and to fix the price so that within a reasonable time, or by a reasonable volume of sales, the so-called development cost may be wiped out. Thereafter the product may be sold on the basis of the continuing cost of actual production. While this system is extensive, it does not cover the cost of many of those original researches which may have been absolutely necessary. The argon tungsten lamp, in its development cost, did not carry the expenses of Rayleigh and Ramsay's work, and so there will probably always be some such classification of research work necessary.

Under such a classification, the part of research I am most interested in promoting is what we may call the unpaid kind, not because it is cheapest, but because it is the most valuable. It is most neglected, most poorly understood, most in need of appreciative support in America.

The separate industries do not need encouragement in research nearly so much as the nation needs it. The industries can be depended on to estimate its value to them, for they take annual inventories. But a country which keeps no books seems to have to depend on instinct and environment for its most valuable research work.

It seems to me that our American colleges have been shortsighted in this respect. This may be explained by the rapidly increasing demand in our growing industries for analytical chemists and chemical engineers, who could at once meet the existing industrial requirements. This demand has kept the chemical departments of our colleges and technical schools very busy with the elementary and analytical side of chemistry and left little room for the synthetical or experimental side. It has also naturally tended toward the development of highly

efficient organizations, equipments and corps of instructors for the preparation of the one type of chemist, but this very success seems frequently to make impracticable the training of men for research. The conscientious American professor has usually devoted his life to bringing his students up to a certain promising stage of interest in science and experiment, only to see them scatter before they have had any experience with questioning nature, or have tried any unbeaten chemical byway.

While I am greatly interested in what might be done for science by technical research laboratories in the industries, I am sure that the university must be the important factor in guiding the pioneer work if we are to be a sufficiently advancing nation.

Let me recall recent words of President Wilson:

> I know I reflect your feeling and the feeling of all our citizens when I say the only thing I am afraid of is not being ready to perform our duty. I am afraid of the danger of shame. I am afraid of the danger of inadequacy. I am afraid of the danger of not being able to express the correct character of the country with tremendous might and effectiveness whenever we are called upon to act in the field of the world's affairs.

These words ring true. The American spirit is characterized by them. But think further a moment. They refer to a fear based upon an entirely corrigible defect. The cure is in our hands. The time when we are called upon to act in the field of the world's affairs is *now*; but it was yesterday, and it will be to-morrow. I maintain that no nation can effectively act in that field at odd or selected moments. It is either doing it much of the time, or it is likely to be unable to do it any of the time.

WILLIS R. WHITNEY

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THE COMMITTEE ON POLICY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE Committee on the Policy of the American Association for the Advancement of Science met on April 17, 1916, in Washington. Messrs. E. L. Nichols, *chairman;* Charles R. Van Hise, *president;* R. S. Woodward, *treasurer,* J. McK. Cattell, W. J. Humphreys, A. A. Noyes, Stewart Paton, E. C. Pickering and L. O. Howard, *permanent secretary,* were present.

The committee on delegates to the meetings was instructed to make an especial effort to secure delegates from the educational and other scientific institutions to the New York meeting, as this will be the first of the large four-year meetings.

The treasurer and the permanent secretary presented financial reports which were ordered printed in SCIENCE.

The committee on new affiliated societies reported that the following societies had been admitted to affiliation: American Genetic Association, Eugenics Research Association, Illuminating Engineering Society, Wilson Ornithological Club, and the Mid-West Forestry Association. The American Institute of Chemical Engineers and the American Society of Heating and Ventilating Engineers were invited to become affiliated.

The treasurer reported with regard to the Colburn bequest and stated that approximately seventy-eight thousand dollars ($78,000) in cash and bonds had been turned over to him by the executors. On motion, the treasurer was authorized to convert cash to the amount of eighty thousand dollars ($80,000) into securities approved by the state laws of New York and Massachusetts for savings banks and trust funds. On motion, it was directed that these investments be made with the advice of a committee of three, of which the treasurer and Mr. A. S. Frissell shall be members, they to select the third member.

The permanent secretary announced the death of Professor Thomas J. Burrill, the chairman of Section G, stating that he had sent, in the name of the committee, a tele-

gram of condolence to the president of the University of Illinois. On motion, such nomination as the sectional committee of Section G may make to fill the vacancy caused by this death shall be final.

A discussion followed with regard to the arrangements for the New York meeting. It was moved and carried that a committee consisting of Messrs. Charles Baskerville, N. L. Britton, J. McK. Cattell, Simon Flexner, M. I. Pupin, Henry F. Osborn, J. J. Stevenson and Edmund B. Wilson, be appointed an executive committee to make the New York arrangements.

The report of the committee on the administration of the Colburn will fund was submitted by Professor Pickering. On motion, it was moved to refer the report back to the committee for revision to include the administration of all research funds of the association, to add Messrs. A. A. Noyes and W. B. Cannon to the committee, and to make a final report to the committee on policy at its next meeting in November. It was suggested further that it might be well to refer the first draft of the report by mail to the members of the committee on policy.

At 10.25 P.M., the committee adjourned.

SCIENTIFIC NOTES AND NEWS

Hilgard Hall has been selected as the name for the new agricultural building being built by the University of California, in honor of the late Eugene Woldemar Hilgard, for a generation professor of agriculture and dean of the college of agriculture of the University of California.

At the meeting of the Franklin Institute, Philadelphia, on May 17, Franklin medals will be presented to Professor Theodore William Richards, director of the Wolcott Gibbs Memorial Laboratory, Harvard University, and to John J. Carty, chief engineer of the American Telephone and Telegraph Company. The Elliott Cresson medal will be presented to the American Telephone and Telegraph Company, Theodore N. Vail, president. Addresses will be made by Professor Richards on "The Fundamental Properties of the Elements," by Mr. Carty on "The Telephone Art" and by Mr. Vail.

H. H. Stoek, professor of mining engineering in the University of Illinois, has been appointed by Governor Dunne, of Illinois, as a member of the commission authorized to consider legislation concerning mines.

The Mary Putnam Jacobi Memorial Fellowship has been awarded to Dr. Mildred Clark, Johns Hopkins, 1914, who will use the fellowship for research work in medical bacteriology with Dr. Theodore C. Janeway at the Johns Hopkins Hospital.

Dr. Alvin Powell has been appointed physician for men and roentgenologist in the infirmary of the University of California.

The position of horticulturist to the Missouri Botanical Garden has been filled by the appointment of Mr. Alexander Lurie. Mr. Lurie is a graduate of Cornell University, and has been in charge of greenhouses and instructor in floriculture, in the University of Maine.

Professor A. L. Kroeber, head of the department of anthropology in the University of California, is spending the present academic year in New York City as a guest of the American Museum of Natural History.

Because of ill health, Professor A. Fraenkel retired from the directorship of the Krankenhaus am Urban in Berlin, on April 1. He is succeeded by Professor A. Plehn, who has been the physician in chief of the medical division for the past thirteen years. Most of his time has been devoted to the study of tropical diseases and diseases of the blood.

Dr. William Palmer Lucas, professor of pediatrics, University of California, has gone to Belgium for relief work in connection with the infants' and children's dietetic problems which have arisen there.

Mr. Shoitsu Hotta, assistant professor of forestry at the Tokyo Imperial University, has entered the Yale School of Forestry. Mr. Hotta will be in the United States for a period of two years.

ACCORDING to the *Nieuwe Courant*, as quoted in *Nature*, the Royal Academy of Sciences of Amsterdam has awarded the following grants from the Van't Hoff Research Fund: $125 to Professor F. Ephraim, of Berne, for the continuation of his studies on the nature of subsidiary valencies; $250 to Dr. P. E. Verkade, of Delft, for the purchase of apparatus for the determination of heats of combustion; $50 to Dr. D. H. Wester, of The Hague, for a chemical examination of certain species of Loranthus; $100 to Dr. C. H. Sluiter, of Vught, for the purchase of Beilstein's handbook and of materials for an investigation of formaldoxime; $100 to Professor E. Jänecke, of Hannover, for the continuation of his work on melting and transition points under high pressures.

AT the sixty-ninth annual meeting of the Paleontographical Society, London, on March 31, Dr. Henry Woodward was reelected president; Dr. G. J. Hinde was elected a new vice-president; Mr. R. S. Herries was reelected treasurer; Dr. A. Smith Woodward was reelected secretary, and Miss Mary S. Johnston, Mr. H. L. Hawkins and Mr. G. W. Young were elected members of council.

PROFESSOR HENRY S. WHITE asks us to state that the footnote on page 591 of the last issue of SCIENCE should have referred to the presidential address of Professor E. B. Van Vleck on "The Rôle of the Point-set Theory in Geometry and Dynamics," *Bulletin of the American Mathematical Society*, Vol. 21 (1915), pp. 321–341.

THE Cutter Lecture on Preventive Medicine and Hygiene was given by Dr. Simon Flexner, director of the Laboratories, Rockefeller Institute for Medical Research, on "The Finer Adjustments of the Immunity Reactions to Recovery from Infection," at the Harvard Medical School on April 26.

THE eleventh Harvey Society Lecture was delivered at the New York Academy of Medicine, on April 29, by Dr. William H. Welch, of the Johns Hopkins University, on "Medical Education in the United States."

LAFAYETTE B. MENDEL, professor of physical chemistry in Sheffield Scientific School, Yale University, will deliver an address on "Abnormalities of Growth" before the experimental medicine section of the Cleveland Academy of Medicine, May 12.

PROFESSOR WALTER B. CANNON, of the Harvard Medical School, gave a lecture before the section on general medicine of the College of Physicians of Philadelphia at Thompson Hall, on April 20, on "An Explanation of some Disorders supposed to have an Emotional Origin."

DR. JAMES WILLIAM WHITE, emeritus professor of surgery in the University of Pennsylvania, and a trustee of the university, died on April 24, aged sixty-six years.

PROFESSOR HOWARD DRYSDALE HESS, of the department of machine design, Sibley College, Cornell University, died on April 22, aged forty-four years.

PROFESSOR HENRY BARBER NIXON, Ph.D., since 1888 in charge of the department of mathematics in Pennsylvania College, Gettysburg, Pa., died on March 30, at his home on the campus.

CHARLES ALBERT DAVIS, peat expert in the U. S. Bureau of Mines, known for his investigations on peat and related subjects, died in Washington on April 9, aged fifty-five years.

CHARLES ALBERT CATLIN for nearly fifty years chemist for the Rumford Chemical Works, known for his work on phosphoric acid and its compounds, died at his home in Providence, R. I., on April 13, aged sixty-seven years.

GEORGE EDWARD PATRICK, chief of the dairy laboratory in the bureau of chemistry of the Department of Agriculture, died in Washington, on March 25.

DR. EDGAR MOORE SENSENEY, professor of diseases of the nose, throat and chest in Washington University, died in St. Louis, on April 7, aged sixty years.

DR. WILLIAM FREDERICK KING, chief astronomer of the Canadian government, superin-

tendent of the Geodetic Survey of Canada, and director of the Dominion astronomical observatory, died on April 23, at the age of sixty-two years.

Professor F. Schenck, the director of the physiological institute at Marburg, has died, aged fifty-three years.

Dr. P. Chappuis-Sarasin, the Swiss physicist, has died at Basel at the age of sixty-one years.

The cornerstone of the laboratory building of the Brooklyn Botanic Garden was laid, with brief formalities, on Thursday afternoon, April 22, 1916. Plans and specifications have been approved for a children's garden building to be erected this spring at a cost of $6,550. A large rock garden is also being completed this month, and four additional wings of the plant houses are under construction.

The authorities of the University of Alabama and of the Bryce Insane Hospital, have joined in making the lands of the two institutions, with an area of approximately 1,200 acres, into a bird sanctuary, and at the same time members of the faculty of the University of Alabama have been instrumental in the formation of a bird club, to be known as the Tuscaloosa Bird Club.

Mr. Ogden Mills, of New York, has agreed to provide a gift of $8,250 this year and $8,250 during the next academic year for the maintenance of the D. O. Mills Expedition from the Lick Observatory of the University of California to the southern hemisphere, the expedition making its headquarters at Santiago, Chile.

The eighth semi-annual meeting of the American Institute of Chemical Engineers will be held in Cleveland, O., from June 14 to 17.

A new scientific association has been formed at the University of Alabama with William F. Prouty, professor of geology, as president. The members of the association are restricted to the scientific men of the faculty. The purpose of the association is chiefly to stimulate scientific research, and to provide means for the review of highly specialized publications dealing with subjects on the border-line of the different sciences.

The Chemists' Club of New York announces the establishment of a scholarship fund, the income from which, approximately $500 per year, is to be devoted to assisting financially deserving young men to obtain education in the field of industrial chemistry or chemical engineering. This scholarship has been endowed by Dr. Victor G. Bloede, a prominent manufacturing chemist of Baltimore. Its benefits will be open to properly qualified applicants without restriction as to residence, and may be effective at any institution in the United States which may be designated or approved by the Chemists' Club. Applicants must, as a minimum qualification, have completed a satisfactory high-school training involving substantial work in elementary chemistry, physics and mathematics and present a certificate showing that they have passed the entrance examination requirements of the college entrance examination board or its equivalent. Preference will be given to young men who have supplemented these minimum qualifications with additional academic work, especially in subjects which will form a suitable ground work for the more advanced study of applied chemistry and chemical engineering. All inquiries should be addressed to the Bloede Scholarship Committee of the Chemists' Club, 50 East 41st Street, New York City. Applications for the academic year 1916–17 should be in the hands of the committee on or before June 1, 1916. The scholarship will be awarded and candidates selected and notified on or before July 1, 1916.

UNIVERSITY AND EDUCATIONAL NEWS

The University of California regents have adopted a budget for 1916–17 which contemplates the expenditure of $2,565,975. The principal change as compared with the budget of the previous year is an outright addition of $70,000 from its general fund to the university's annual provision for the maintenance of

the University of California medical school. For the year ending June 30, 1917, the University of California will expend $321,200 on its medical work, the principal items being as follows: salaries, $87,450; budgets, $49,750; for the maintenance of the University of California Hospital (the new 216-bed teaching hospital, under the complete ownership and management of the university), $134,000, of which $35,000 will come from receipts from patients and the balance from the income on endowment and from the general fund of the university; for the maintenance of the George Williams Hooper Foundation for Medical Research, $50,000.

A NEW separate department of biochemistry and pharmacology has been established in the University of California Medical School. It will be headed by Dr. T. Brailsford Robertson as professor of biochemistry.

PERCY R. CARPENTER, of Amherst College, has resigned his position as associate professor of hygiene and physical education to accept the post of professor in the Worcester Polytechnic Institute.

WILLIAM J. ROBBINS, Ph.D. (Cornell, '15), has been appointed professor of botany in the Alabama Polytechnic Institute, Auburn, Ala.

DR. H. L. HOLLINGWORTH has been promoted to be associate professor of psychology in Barnard College, Columbia University.

THE executive committee of the City and Guilds of London Institute has appointed Professor G. T. Morgan, F.R.S., of the Royal College of Science, Dublin, to the chair of chemistry at the Institute's Technical College, Finsbury, vacant by the death of Professor Meldola.

DISCUSSION AND CORRESPONDENCE

PUBLIC HEALTH WORK

TO THE EDITOR OF SCIENCE: I have previously[1] called attention to what, for a lack for a better designation, may be termed a type of medical fallacy in public health. In Dr. C. R. Bardeen's article, "Aims, Methods and Results in Medical Education," there again appears in your columns another type of medical fallacy in public health. On page 377 of your issue of March 17, he states:

> No sharp line can be drawn between preventive medicine, on the one hand, and curative medicine, on the other hand. Public health officers can not do thoroughly effective work if they can not apply remedies to diseased individuals as well as to other sources of danger to the public health. By far the most effective public service in this country to-day is the United States Public Health Service and here treatment of individuals and treatment of environment are carried on hand in hand.

These sentences define a fallacy which is the outgrowth of medical training and viewpoint, in which emphasis is placed on treatment and not on prevention. Medical education is a training to enable a man to derive an income through the practise of a profession. In our present organization of society, the members of the medical profession obtain their income by the cure of diseases that exist, and do not receive compensation for disease which is prevented. The matter having a financial basis, the emphasis must be placed on cure, not on prevention.

He speaks of "treatment of individuals and treatment of environment" in the same breath, as if they are, or could be, in any way similar. Apparently the vast differences in personal rights and property rights before the law are completely ignored.

With reference to his first sentence, a line of demarcation can, and must be, drawn between preventive medicine and curative medicine in public health work. Under our form of government, it is not possible for public health officers to apply by compulsion remedies to diseased citizens. Such would be totally repugnant to our institutions and our ideals of government.

Dr. Bardeen states that in the United States Public Health Service "treatment of individuals and treatment of environment are carried on hand in hand." A high-school boy would at once recognize this as an error of statement. The constitution, neither directly nor by implication, gives to the federal government, or to any of its bureaus or depart-

[1] SCIENCE, August 20, 1915, p. 243.

ments, the right to apply medical treatment to individuals. The functions of the Public Health Service are limited to interstate or foreign regulation, except in such cases where the state itself invites and authorizes the Public Health Service to perform specific functions within its territory. Neither may treatment, if it may be called such, be applied to environment or property except by due process of law, in such a manner as to duly conserve property rights.

Fallacies of this type are due to the fact that, while the medical profession is much engaged in public health work because its members have in the past come nearest to having the qualifications necessary for such work, physicians are apparently too greatly limited in their understanding of government to realize that, while public health has medical aspects of the greatest importance, nevertheless public health is a function of community life, founded upon law and our form of government. Until such time as all people will learn that the ideals of a single profession, no matter how excellent, can not be applied to people in the mass, except as such ideals are founded on the law, and are in strict accord with fundamental rights of individuals and well-defined principles of government, we may expect to find fallacies such as this continually appearing.

Harold F. Gray

THE CENTIGRADE THERMOMETER

"No man that has any regard for his reputation will care to say that the irrational, inconvenient Fahrenheit scale ought to be maintained," is the modest and diplomatic way in which Representative Johnson, editor of a country newspaper, passes judgment on some two hundred millions of people who never knew it. As for being irrational, any heat scale is arbitrary; if inconvenient, it could never have been generally accepted. Nine tenths, probably, of the use of a thermometer is for the weather; and practically the F. degree is a convenient one, while the C. degree, being about twice as coarse, would involve fractions. Some people perhaps think that a centigrade scale has something to do with grams and liters; but I never could see any special convenience in 15.°5 C. as a temperature reading in density determinations. A scale is convenient if you find it so; it is rational if its divisions are such that the quantities commonly used can be expressed in units.

In all English-speaking countries all technical and manufacturing work uses the F. scale; and all the common people are familiar with it. Unless there is some reason for change it should be let alone. The fact that I and a few hundred other people in this country are familiar with the thermometer used in France and Germany is no adequate reason why a hundred millions of our fellow-citizens should be put to a great inconvenience which will never benefit them or their descendants in the least. Perhaps a rose by any other name would smell as sweet; but why not keep on calling it a rose?

A. H. Sabin

Flushing, N. Y.,
March 11, 1916

SCIENTIFIC BOOKS

Transactions of the International Union for Cooperation in Solar Research. Vol. IV. (Fifth Conference), Manchester, At the University Press. 1914. Price $3.25 net.

This tri-lingual volume (English, French, German), representing the high water mark of friendly cooperation in scientific research, comes as an almost painful reminder of conditions shattered by war, of friendships replaced by enmity, of constructive science replaced by destructive art.

The Solar Union, not quite adequately described by its title, was organized, largely under American auspices, as a common meeting ground for the most distinguished students of astrophysics throughout the world. From the beginning its cosmopolitan character has been served through holding stated meetings in divers lands. The present volume contains an account of the fifth of these meetings, which was held at Bonn in the summer of 1913. In addition to reports upon the progress of mat-

ters formally undertaken by the Union at former meetings, we find a considerable number of accounts of investigations privately conducted and submitted to the Union as coming within its general province, the whole composing a *pot pourri* probably beyond the competence of any one person not a professed encyclopedist. Among the matters discussed we note, by way of illustration only, the sun's rotation; the measurement of its radiant energy; the measurement of wave-lengths; observation of sun spots, prominences and faculæ; the organization of solar eclipse observations; the study of solar vortices; the refraction of light in the solar atmosphere; the sun's magnetic field; etc.

While in general the papers dealing with these several themes can hardly be regarded as addressed to the lay reader, when taken in connection with the discussions evoked, they furnish to the serious student the best available résumé of current opinion upon controverted questions relating to the sun, as well as upon certain wider aspects of general physics. The reporting appears to have been well done, although, perchance, something of geographic prophecy rather than current fact is to be found in the secretary's classification of Finland as an independent country and the assignment of Kopenhagen to Norway, in the tabular list of delegates.

The personal reports of American participants in the conference confirm the impression produced by the narrative parts of the volume, that the hosts left nothing undone that could promote the social side of the conference and the enjoyment of their guests. How bitter must be to many of these the commentary of August, 1914, upon the chairman's closing words in August, 1913, "und so hoffe er dass die Bonner Versammlung nützbringend für die Wissenschaft und angenehm für die Theilnehmer werden würde, so dass sie später gern an Bonn zurückdenken könnten."

While it is not to be supposed that the present European war will end international cooperation for scientific research it has certainly placed obstacles in the way thereto, and may it not be that in the coming decade men of divers tongues, accustomed to work together for the advancement of knowledge, may find a major line of usefulness in collectively seeking to restore good will to the world.

GEO. C. COMSTOCK
UNIVERSITY OF WISCONSIN

Representative Procedures in Quantitative Chemical Analysis. By FRANK AUSTIN GOOCH, Professor of Chemistry and Director of the Kent Chemical Laboratory in Yale University. New York and London: John Wiley & Sons, Inc. 1916. Pp. viii + 250. Price $2.00 net.

In the volume entitled "Methods in Chemical Analysis" published in 1912, the author gave to his colleagues a fund of material drawn from the records of a laboratory which for more than a generation has outranked most others in the development of authoritative analytical procedures. In the volume under review he writes from the fullness of his experience as a teacher of quantitative chemical analysis, one whose influence has been widely felt, through both his publications and his pupils. The manual is intended as an introduction to representative analytical procedures.

The book opens with a brief discussion of non-reversible and reversible reactions, including the mass law and the principle of LeChatelier. This is succeeded by a full consideration of the processes of weighing and measuring. The analytical procedures are, as usual, subdivided into gravimetric and volumetric analyses, the latter including brief sections upon gasometric and colorimetric methods. The concluding chapter deals with systematic analyses of brass, limestone, silicates, substances yielding ammonia, and a few applications of indirect methods of analysis. Among the volumetric procedures much space is devoted to iodometric processes, many of which have been devised or developed in the Kent Laboratory. Iodometric processes are, as the author states, among the most accurate and satisfactory available, and do not, in general, receive the recognition which they deserve.

While detailed directions for "experimental processes" (that is, analyses to be performed) are numerous, the usefulness of the manual is by no means limited to these, since the range of processes discussed in the text is exceedingly wide. The richness of the author's experience is reflected in many unusual suggestions as to technique and reagents, such, for example, as the employment of anthracene filters, and the use of sodium tungstate as an absorbent. The treatment of such topics as the variations in solubility of precipitated substances under varying conditions, colloids, the washing of precipitates, electrolysis, normal solutions and indicators is broad and scientific, and should give the thoughtful student a clear notion that analytical chemistry is not only much more than a question of manual skill, but something demanding his best intellectual efforts. In a few instances, notably the basic acetate process, the explanation of the part played by the various reagents might to advantage be somewhat elaborated.

The book is a noteworthy and valuable addition to the literature of analytical chemistry. It contains much that is of novel interest to a more experienced analyst, but it is probable that many teachers will question whether a beginner, lacking a background of experience, will be able to appreciate and use the descriptive material which is included in the text, but not directly applied to definite analyses. This material is, however, so arranged as to permit of selection, and it is all stimulating to the interested worker.

H. P. Talbot

The Embryology of the Honey Bee. By James Allen Nelson, Ph.D. Princeton University Press, Princeton, N. J., 1915.

A monograph of 282 pages with 95 figures in the text and six plates is an achievement in itself even when one deals with a comparatively well-known subject; but the present monograph is not simply a compilation. Dr. Nelson has incorporated in this work a great deal of his own research and many original observations. His account of the work done by others is accurate and, while preserving his own point of view, he displays in his criticism the admirable quality of abstaining from personal remarks which so often mar the pages of scientific papers.

It would be very difficult to review the whole book in detail since many chapters naturally deal with facts already known to science, which merely find their confirmation here. I shall therefore endeavor only to emphasize some of the observations new to science and to point out certain shortcomings in this otherwise excellent book. Thus, in the chapter on cleavage, Nelson makes the interesting statement that "the size of the nuclei is, in a given egg, quite uniform from the beginning to the end of the period under consideration, *but varies considerably in different eggs,* ranging from 9–14 microns" (p. 21) (italics are mine). In every other respect Nelson's observations on cleavage are in harmony with those of other investigators. The figures accompanying this chapter are fairly good, but the addition of a figure representing a sagittal section through an egg at the end of the cleavage process would have been advisable. The chapter on the formation of the rudiments of the mid-intestine is accompanied by excellent figures and gives new support to the opinion expressed by the reviewer and others that the mesenteron is derived from the mesoderm, although Nelson believes that a choice is possible between this interpretation and that of *Carrière,* according to which the mesenteron rudiments may be considered to be purely blastodermal in origin, such a choice depending "largely on the theoretical bias of the interpreter." In the next chapter Nelson comes to the conclusion that both the "Rz" cells described by the reviewer and the "yolk plug" are identical with the "cephalo-dorsal body." This affords the reviewer an opportunity to state that he, too, is now of the same opinion. That the reviewer has never before come out with a statement to this effect, is due to the unusually personal note struck by his critics, even to an insinuation of motives other than a desire to find out the truth. In such cases silence seems always to be the best answer. With the fall of the interpretation

of the "Rz" cells as derivatives of the fused polar bodies and with the new light thrown on the spermatogenesis of the honey bee, the reviewer has been fully, if tacitly, converted to the interpretation of the origin of the sex-glands from the visceral wall of the mesodermal tubes as promulgated by Wheeler and Heymons and accepted by Nelson. Of especial interest are the chapters on segmentation and nervous system. It is rather unfortunate that instead of giving a diagram of his own, representing segmentation in insects, Nelson reproduces in Fig. 36 a diagram from Snodgrass, which can not be considered correct. Nelson himself is aware of this, as may be seen from his footnote on page 106. It is important to mention that Nelson describes and figures the evanescent appendages of the tritocerebral or intercalary segment in *in toto* views of the egg (VIII*a*, 3Br). Although the truth of his statement can not be doubted, this as well as the following figures are not conclusive and we regret that no figure is given of a transverse section through the region of the tritocerebrum as described on page 106. Another point of interest is the absence of a segment between the mandibles and the maxillæ as described by Folsom for *Anurida*. The reviewer has never been able to accept Folsom's interpretation and finds in Nelson's description a new proof against the existence of such a segment. On the other hand, the rudiments of the second maxillæ (the future lower lip) in the honey bee appear well represented in Figs. X.–XIII. The rudimentary appendages representing the future thoracic legs disappear before the larva is hatched. The statement that the abdomen consists of 12 segments must be accepted as correct, but a drawing of the sagittal section showing all segments is wanting. A feature of great importance, especially for future investigators, is the table showing the rate of development. The data accumulated by Nelson for this are much more correct and detailed than those obtained by any of his predecessors. The drawings are well executed and for the most part original. Some of them are especially welcome, as for instance Figs. 1 and 2 showing the external structure of the egg, Fig. 39 showing the cephalic portion of the nervous system of a newly hatched larva, Figs. 63 and 64 showing the tracheal system and the figures reproduced in the plates.

Many readers will probably regret that no account is given of oogenesis, of spermatogenesis or of fertilization. To be sure, the inclusion of these chapters would have increased the size of the book as well as required careful sifting of data and a great deal of original, tedious reinvestigation. At the same time it would be difficult to find a more appropriate place for these chapters than in a monograph on embryology. But it is scarcely fair to criticize the author for omitting to deal with a subject which does not necessarily come within the scope of his work. Dr. Nelson's is the first comprehensive monograph which has ever been printed on the embryology of the honey bee. It will be of great value both to the investigator and the student and we should be truly grateful to its author for having presented us with a work of such high standard.

ALEXANDER PETRUNKEVITCH

SCIENTIFIC JOURNALS AND ARTICLES

THE March number (Vol. 22, No. 6) of the *Bulletin of the American Mathematical Society* contains: Report of the twenty-second annual meeting of the society, by F. N. Cole; Report of the winter meeting of the society at Columbus, by H. E. Slaught; "On Pierpont's definition of integrals," by M. Fréchet; "Reply to Professor Fréchet's article," by J. Pierpont; Review of Carmichael's Theory of Numbers and Diophantine Analysis, by L. E. Dickson; "Notes"; and "New Publications."

THE April number of the *Bulletin* contains: "Some remarks on the historical development and the future prospects of the differential geometry of plane curves," by E. J. Wilczynski; "A certain system of linear partial differential equations," by H. Bateman; "Changing surface to volume integrals," by E. B. Wilson; "A new method of finding the equation of a rational plane curve from its parametric equations," by J. E. Rowe; "The physicist J. B. Porta as a geometer," by G.

Loria; Review of Pierpont's Functions of a Complex Variable, by H. P. Manning; "Shorter Notices": Snyder and Sisam's Analytic Geometry of Space, by R. M. Winger; Slichter's Elementary Mathematical Analysis, by L. C. Karpinski; Ford's Automorphic Functions, by A. Emch; Gibb's Interpolation and Numerical Integration and Carse and Shearer's Fourier's Analysis and Periodogram Analysis, by M. Bôcher; Herglotz's Analytische Fortsetzung des Potentials ins Innere der anziehenden Massen, by W. R. Longley; Lange's Das Schachspiel, by L. C. Karpinski; Ince's Descriptive Geometry and Photogrammetry, by V. Snyder; "Notes"; and "New Publications."

SPECIAL ARTICLES

THE PRESSURE OF SOUND WAVES

In his "Wärmestrahlung"[1] Planck, after proving from electromagnetic theory that the pressure of radiation equals the volume density of radiant energy, shows that the corpuscular theory of light would give a pressure twice as great. From this he infers that the Maxwell radiation pressure can not be deduced from energy considerations, but is peculiar to the electromagnetic theory and is a confirmation of that theory. The implied conclusion is that mechanical waves would not exert a pressure of this magnitude. It may be well to recall, therefore, that Lord Rayleigh has shown, from energy consideration,[2] that transverse waves in a cord exert a pressure equal to the linear energy density, and that sound waves in air must cause a pressure equal to the volume density of energy in the vibrating medium. Altberg[3] has made the conclusions of Rayleigh the basis of a method of determining the intensity of sounds.

As the pressure due to sound waves in a gas must be ultimately the result of molecular impacts, it would seem probable that the magnitude of this pressure may be determined from the elementary kinetic theory, and this proves to be the case. Consider an extended wave incident normally on a unit surface. According to the kinetic theory, the molecules which strike this surface are reflected with the same velocity that they had just before impact. As the surface is small in comparison with the extent of the wave front, we need not follow the history of these reflected molecules, which will immediately become dispersed in the passing wave in all directions. In other words, under these conditions no stationary waves will be formed by reflection, and we may confine our attention to the effect of the incident wave. Of course there will also be increased pressure on the rear surface due to the diffracted waves, but this will not affect the pressure on the front surface. At the instant that the wave front strikes the surface imagine the whole wave length divided into thin strips parallel to the surface, s in number and each of thickness x, so that sx is equal to one wave-length. The velocities of displacement due to the wave are mass effects, but it seems proper to add them to the different individual velocities of the gas molecules which move *en masse*. Let the velocities of wave displacement in the successive strips be $u_1, u_2, \ldots u_s$. The component velocities of translation of the gas molecules normal to the surface are U_1, $U_2, \ldots U_s$. The two other components contribute nothing to the pressure on the surface. The resultant velocity of the molecules having a velocity of translation U_1 in the first strip will be $U_1 + u_1$. As they are reflected with the same velocity, the change of momentum of each molecule is

$$2m(U_1 + u_1) = f.dt,$$

where m is the mass of each molecule and $f.dt$ the impulse of the force during collision. If N_1 is the number of molecules per unit volume having the velocity U_1, the number in the strip of thickness x is N_1x and if t_1 is the time required for the strip to move a distance x,

$$N_1x = N_1(U_1 + u_1)t_1.$$

Taking account of the fact that half the molecules of this class will be moving away from the surface, the total change of momen-

[1] "Wärmestrahlung," 2d ed., p. 58.
[2] *Phil. Mag.*, 3, 338, 1902.
[3] *Ann. der Phys.*, 11, 405, 1903.

tum of all the molecules of this class during the time t_1 is

$$N_1 m(U_1 + u_1)^2 t_1 = \Sigma f.dt.$$

The average pressure during the interval t_1 is $\Sigma f.dt/t_1$, therefore,

$$N_1 m(U_1 + u_1)^2 = p_1.$$

Similarly for all the strips as they successively strike the surface up to the last, where

$$N_1 m(U_1 + u_s)^2 = p_s.$$

Squaring and adding for all values of u from u_1 to u_s,

$$N_1 m(sU_1^2 + 2U_1 s\Sigma u_s + \Sigma u_s^2) = \Sigma p_s.$$

But Σu_s throughout the wave is zero, $\Sigma p/s$ is the average pressure during the impact of the whole wave, and $\Sigma u^2/s$ is u^2, the mean square velocity due to vibration, hence after dividing by s,

$$N_1 m(U_1^2 + u^2) = P_1$$

and the same is true of all the other classes of molecules with velocities from U_1 to U_n. If the total number of molecules of all classes is $N_1 = N_1 + N_2 + N_3$, etc., the final resultant effect after adding all the expressions for P_n will be

$$Nm(U^2 + u^2) = \Sigma P_n = P,$$

where U^2 is the mean square translational velocity $= \Sigma N_n U_n^2/N$. The kinetic theory shows that the pressure is NmU^2 when no sound waves are passing. Hence the increased pressure due to the waves is

$$Nmu^2 = \rho u^2,$$

where ρ is the density of the gas.

If the equation of the wave motion is

$$y = a \cos (2\pi/\lambda)(x - Vt),$$

$$u = dy/dt = a(2\pi/\lambda) V \sin (2\pi/\lambda)(x - Vt),$$

and, since the mean value of $\sin^2$ is 1/2,

$$u = \tfrac{1}{2}a^2(2\pi/\tau)^2 = \tfrac{1}{2}a^2\omega^2,$$

and the pressure due to the waves is $\rho u^2 = \tfrac{1}{2}\rho a^2\omega^2$, which also represents the maximum kinetic energy or mean total energy of the waves per unit volume, in agreement with Rayleigh's conclusion.

The same result might have been reached directly by assuming that the pressure of a gas is proportional to the mean square velocity of the molecules, however that velocity may be produced. The symmetrical positive and negative values of u would cause the products $U_n u_s$ to vanish in forming the squares of the resultant velocities, so that u^2 would be the increase in the mean square velocity, leading to the same result as that given above.

When we consider the propagation of sound waves in air in molecular rather than in mass terms the expression potential energy loses its meaning. The entire energy of the waves may be expressed in terms of molecular kinetic energy. The conclusion that $p = \rho u^2$ is equivalent to saying that the pressure due to sound waves is equal to twice the mean density of kinetic energy in the medium. When stated in this form, the results agree with those obtained by Planck for the corpuscular theory. The mean kinetic energy is twice as great in one case as in the other.

In the case of stationary waves, the energy density is evidently twice as great as in the incident waves alone; and the mean square velocity from node to node deduced from the mathematical expression for the wave disturbance, and hence the pressure, is likewise twice as great.

The absolute temperature of a gas is proportional to the mean square velocity of the molecules. Ordinarily we should limit this relation to the case where the motion is entirely chaotic, not *en masse*. In either progressive or stationary waves there is an increased mean square velocity in the direction of propagation which would record itself as an increase of temperature on any measuring instrument. In particular, at the loops of stationary waves where there are no density changes no lateral change of pressure would occur, while in the direction in which the waves travel there would be an increase of mean square velocity. In a sense there would be a state of polarized temperature. A thin bolometer strip would undoubtedly indicate a higher temperature when the waves are inci-

dent on its flat side than when they are incident on its edge. The maximum sound-wave pressure found by Altberg, for very intense stationary waves, was about .26 dyne. Since the pressure of a gas is proportional to the absolute temperature, $dT/T = dP/P$. From this it may be calculated that the increase of temperature indicated by a thin bolometer strip on which the waves exert a pressure of .26 dyne would be about .000075° at atmospheric pressure and a temperature of 17° C. or 290° absolute.

E. P. Lewis

University of California

RUDIMENTARY MAMMÆ IN SWINE A SEX-LIMITED CHARACTER[1]

The inheritance of the rudimentary mammæ found on the lower part of the scrotum of the boar and on the inside of the thighs to the rear of the inguinal pair in the sow, was reported as typically sex-limited by the writer in 1912 and 1913. Later, in 1914, due to the failure to discover a boar homozygous for the character, an attempt was made to classify the inheritance as sex-linked in nature. Certain more recent discoveries, due largely to a few selected matings, have cleared up the difficulties which in 1914 were believed to exist, and make the earlier interpretation more probable.

The case in point is as follows: A Duroc Jersey boar possessing the rudimentaries was mated to a grade black sow lacking them. A litter of nine pigs was farrowed, four of the boars having rudimentaries, and one lacking them, while three of the sows lacked rudimentaries and the fourth possessed them. Coupled with the evidence on the inheritance of this character published previously, this breeding performance indicates that both the Duroc Jersey boar and the grade black sow were heterozygous for this character.

One of the boars possessing rudimentaries from this litter was mated to the four sows of the litter with the following results:

[1] Paper No. 2 from the Laboratory of Animal Technology, Kansas Agricultural Experiment Station.

Record Number	Apparent Hereditary Constitution	Males		Females	
		With Rudimentaries	Without Rudimentaries	With Rudimentaries	Without Rudimentaries
Sow 26.....	RR	4	0	3	0
Sow 27.....	Rr	4	0	3	2
Sow 28.....	rr	3	0	0	2
Sow 29	rr	4	0	0	4

This breeding performance very definitely indicates that the boar was homozygous for the rudimentary mammæ. All of the boar pigs that he sired possessed the character, even though two of the sows were of a type not to transmit it at all. If he were heterozygous for the character, then at least part of the seven male pigs from sows 28 and 29 should have lacked the rudimentaries; the chances of their all having them being one out of 128. The discovery of a boar homozygous for the rudimentaries removes the principal stumbling block to the simple sex-limited theory.

Davenport and Arkell have developed a scheme which bridges the discrepancies between sex-limited and sex-linked inheritance, even when apparently homozygous animals exist. Since, however, the sex-limited explanation advanced by Wood seems to cover all the facts that are involved in this case, and since it is much simpler, the writer prefers thus to interpret these results.

Edward N. Wentworth

Literature Cited

Arkell, T. R., and Davenport, C. B. Horns in Sheep as a Typical Sex-limited Character. Science, N. S., Vol. 35, pp. 375–377.

Wentworth, E. N. Another Sex-limited Character. Science, N. S., Vol. 35, p. 986.

Inheritance of Mammæ in Duroc Jersey Swine. *Amer. Nat.*, Vol. 47, pp. 257–278.

Inheritance of Rudimentary Mammæ in Swine. *Proc. Iowa Acad. Sci.*, 1914, Vol. 21, pp. 265–268.

Wood, T. B. Note on the Inheritance of Horns and Face Color in Sheep. *Jour. Agr. Sci.*, Vol. 1, p. 364.

THE NATIONAL ACADEMY OF SCIENCES

The sessions of the annual meeting of the National Academy of Sciences were held in the United States National Museum, Washington,

D. C., on April 17, 18, 19, 1916. Seventy-two members were present as follows:

Charles Greeley Abbot, J. Asaph Allen, J. S. Ames, George F. Becker, B. B. Boltwood, Nathaniel Lord Britton, Henry Andrews Bumstead, D. H. Campbell, Walter Bradford Cannon, J. McKeen Cattell, W. B. Clark, F. W. Clarke, J. M. Clarke, George C. Comstock, E. G. Conklin, J. M. Coulter, Whitman Cross, William H. Dall, C. B. Davenport, W. M. Davis, Arthur L. Day, H. H. Donaldson, Jesse Walter Fewkes, Simon Flexner, Arnold Hague, George E. Hale, E. H. Hall, R. A. Harper, John F. Hayford, W. F. Hillebrand, W. H. Holmes, W. H. Howell, Joseph Iddings, Herbert Spencer Jennings, Armin Otto Leuschner, F. R. Lillie, Jacques Loeb, Graham Lusk, F. P. Mall, S. J. Meltzer, Lafayette B. Mendel, C. Hart Merriam, Ernest Merritt, Robert A. Millikan, E. H. Moore, Edward W. Morley, H. N. Morse, F. R. Moulton, E. L. Nichols, A. A. Noyes, George H. Parker, Edward C. Pickering, M. I. Pupin, F. L. Ransome, H. Fielding Reid, Ira Remsen, Edward B. Rosa, Charles Schuchert, William B. Scott, E. F. Smith, William E. Story, C. R. Van Hise, E. B. Van Vleck, Charles D. Walcott, Arthur G. Webster, William H. Welch, William M. Wheeler, David White, H. S. White, Edmund B. Wilson, R. W. Wood, R. S. Woodward.

The following scientific program was carried out in full:

MONDAY, APRIL 17

Morning Session

"On Permeability of *Endothelia*," by S. J. Meltzer.

"The Influence of Morphin upon the Elimination of Intravenously Injected Dextrose," by I. S. Kleiner and S. J. Meltzer.

"The Sex of a Parthenogenetic Frog," by Jacques Loeb.

"The Distribution of the Chondrosomes to the Spermatozoa in Scorpions," by Edmund B. Wilson.

Symposium on the Exploration of the Pacific

Arranged by W. M. Davis (by invitation of the Program Committee)

"On Exploration of the Pacific," by W. M. Davis.

"The Importance of Gravity Observations at Sea in the Pacific," by J. F. Hayford.

"A New Method of Determining Gravity at Sea," by L. J. Briggs, president of the Philosophical Society of Washington.

"The Problem of Continental Fracturing and Diastrophism in Oceanica," by C. Schuchert.

"Petrological Problems in the Pacific," by J. P. Iddings.

Afternoon Session

"A New Form of Metamorphism," by Arthur Keith (introduced by George F. Becker).

"Contributions to the Petrology of Japan, Philippine Islands and the Dutch Indies," by J. P. Iddings and E. W. Morley.

Symposium on the Exploration of the Pacific (Continued from the Morning Session)

"The Extent of Knowledge of the Oceanography of the Pacific," by G. W. Littlehales, Hydrographic Engineer, United States Hydrographic Office.

"Marine Meteorology and the General Circulation of the Atmosphere," by C. F. Marvin, Chief of the United States Weather Bureau.

"On the Distribution of Pacific Invertebrates," by Wm. H. Dall.

"Land Mollusca of the Pacific," by H. A. Pilsbry, Academy of Natural Sciences of Philadelphia.

"Marine Algæ of the Pacific," by W. G. Farlow.

"Problems of the Pacific Floras," by D. H. Campbell.

"The Pacific as a Field for Anthropological Investigation," by J. W. Fewkes.

Papers of the Regular Program

"Hereditary Transmission of Defects resulting from Alcoholism," by Charles R. Stockard. (By invitation of the Program Committee.)

"Recent Observations on the Activity of some Glands of Internal Secretion," by W. B. Cannon.

"Studies in the Water Content of the Nervous System," by H. H. Donaldson.

First William Ellery Hale Lecture, by Henry Fairfield Osborn, President of the American Museum of Natural History. Subject: "The Origin and Evolution of Life on the Earth." (Illustrated.)

The lecture was followed by a conversazione in the art gallery of the museum.

TUESDAY, APRIL 18

Morning Session

"Some Recent Results of Solar Research," by George E. Hale.

"An Investigation of the Suggested Mutual Repulsion of Fraunhofer Lines," by Charles E. St. John (introduced by G. E. Hale).

"Anomalous Dispersion Phenomena in Electric Furnace Spectra," by Arthur S. King (introduced by G. E. Hale).

"Illustrations of the New Spectroscopic Method of Measuring Stellar Distances," by Walter S. Adams (introduced by G. E. Hale).

"Some Results with the New 10-inch Photographic Telescope," by Harlow Shapley (introduced by G. E. Hale).

"The Pyranometer, an Instrument for the Measurement of Sky Radiation," by C. G. Abbot and L. B. Aldrich.

"Invisible Companions of Binary Stars," by G. C. Comstock.

"Theory of Electric Conduction in Metals," by Edwin H. Hall.

"The Evolution of the Stars," by F. R. Moulton.

"The Minor Planets discovered by James C. Watson," by A. O. Leuschner.

Afternoon Session

"Biography of Professor Theodore Nicholas Gill," by Wm. H. Dall. (By title.)

"Biography of Professor Edward Singleton Holden," by W. W. Campbell. (By title.)

"Biography of Professor Simon Newcomb," by W. W. Campbell. (By title.)

"Biography of John Shaw Billings," by Fielding H. Garrison. (By title.)

"Report of the Work of the Committee upon the Panama Canal Slides," by Charles R. Van Hise, chairman.

"The Mechanics of the Panama Slides," by H. Fielding Reid.

"The Present State of Knowledge of the Extreme Ultra-violet," by Theodore Lyman, Director Jefferson Physical Laboratory, Harvard University. (By invitation of the Program Committee.)

"A Redetermination of e and N," by Robert A. Millikan.

"The Relation of Investigational Work to the Enforcement of the Food and Drugs Act," by Carl L. Alsberg. (By invitation of the Program Committee.)

"Recent Exploration on the Mesa Verde National Park," by J. Walter Fewkes.

"Further Evidence on the Nature of Crown Gall and Cancer and that Cancer in plants offers strong presumptive evidence both of the parasitic origin and of the essential unity of the various forms of Cancer in man and animals," by Erwin F. Smith.

Wednesday, April 19

Second William Ellery Hale Lecture, by Henry Fairfield Osborn, President of the American Museum of Natural History. Subject: "The Origin and Evolution of Life on the Earth." (Illustrated.)

PRESENTATION OF MEDALS

At the annual dinner of the academy held at the Hotel Raleigh on April 18, 1916, the medals for eminence in the application of science to the public welfare were awarded to Cleveland Abbe and to Gifford Pinchot, and the James Craig Watson medal was awarded to Armin Otto Leuschner.

The president announced the following deaths since the last annual meeting of the academy:

John Ulric Nef, died on August 13, 1915, elected in 1904.

Frederic Ward Putnam, died on August 18, 1915, elected in 1885.

Arthur W. Wright, died on December 19, 1915, elected in 1881.

Eugene W. Hilgard, died on January 8, 1916, elected in 1872.

The reports of the president and treasurer for the year 1915 were presented to the academy in printed form as transmitted to the Senate of the United States by the president of the academy.

REPORT OF THE HOME SECRETARY

THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

Sir: I have the honor to present the following report on the publications and membership of the National Academy of Sciences for the year ending April 19, 1916.

The *Memoirs of the National Academy of Sciences*, Volume 12, part 2, entitled "Variations and Ecological Distribution of the Snails of the Genus *Io*," by Charles C. Adams, has been published and distributed, as has also the memoir forming Volume 12, being "A Catalogue of the Meteorites of North America," by Oliver C. Farrington. Volume 14, memoir 1, entitled "Report on Researches on the Chemical and Mineralogical Composition of Meteorites, with Especial Reference to their Minor Constituents," by George Perkins Merrill, is going through the press and the final proof has been passed. It awaits casting and printing before it is published.

The biographical memoirs of John W. Powell, Miers Fisher Longstreth, Charles Anthony Schott, Peter Lesley, Henry Morton and Alfred Marshall Mayer have been published, and that of George William Hill, by Ernest W. Brown, has also been published but not distributed.

Three members have died since the last annual meeting: John Ulric Nef, on August 13, 1915, elected in 1904; Frederic W. Putnam, on August

18, 1915, elected in 1885; and Eugene W. Hilgard, on January 8, 1916, elected in 1872.

One foreign associate, Paul Ehrlich, died on August 20, 1915, elected in 1904.

There are 139 active members on the membership list, 1 honorary member, and 39 foreign associates.

ARTHUR L. DAY,
Home Secretary

REPORT OF THE FOREIGN SECRETARY

I have the honor to report on the work of the foreign secretary for the year ending April 19, 1916.

An attempt has been made, through correspondence with various academies and societies belonging to the International Association of Academies, to secure a partial continuance of some portions of the association's work through the period of the war. Although international meetings are obviously not feasible, it was hoped that a temporary transfer of the functions of leading academy from Berlin to Amsterdam, as suggested by the former body, might serve a useful purpose. Unfortunately, however, certain difficulties of an insuperable nature prevented the proposed transfer, and no further steps can be taken at present.

It was suggested to the Amsterdam Academy by the foreign secretary, also acting in the capacity of secretary of a joint committee of the National Academy and the American Association, that the Accademia dei Lincei be requested to use its good offices to secure the continuation of the work of the Zoological Station at Naples. A favorable reply was received from the president of the Lincei, but the participation of Italy in the war has prevented Dr. Dohrn from retaining the direction of the station, which is now under an Italian administration.

At the request of the president of the Amsterdam Academy, who is also permanent secretary of the International Geodetic Association, the Secretary of State was asked by the academy to use his influence to secure the continued participation of the United States in the work of the association, and the maintenance of the international latitude station at Ukiah, California. Through the action of the Secretary of State, and the interest of members of Congress, the necessary appropriations have been provided.

GEORGE E. HALE,
Foreign Secretary

The following reports from the directors of the trust funds of the academy were presented and the recommendations contained therein adopted.

REPORT OF THE DIRECTORS OF THE BACHE FUND

Mr. Ira Remsen resigned as director of the fund at the annual meeting, 1915. The two remaining members of the committee chose Mr. Arthur G. Webster as the third member, and later the undersigned was elected chairman. Since the annual meeting the following appropriations have been made:

No. 187 to H. H. Lane, State University of Oklahoma, $500, for the purchase of apparatus to be used in a comparative study of the embryos and young of various mammals in order to determine, by physiological experimentation and morphological observations, the correlation between structure and function in the development of the special senses.

No. 188 to H. W. Norris, Grinnell College, $100, for assistance in the analysis of the cranial nerves of Cœcilians (*Herpele* and *Dermophis*).

No. 189 to E. J. Werber, Woods Hole, $230, for assistance in experimental studies aiming at the control of defective and monstrous development: (1) the effect of toxic products of metabolism on the developing teleost egg; (2) the effect of experimentally produced diseases of parental metabolism on the offspring of mammals.

No. 190 to H. S. Jennings, Johns Hopkins University, $200, for assistance in the study of evolution in a unicellular animal multiplying by fission: heredity, variation, racial differentiation in *Difflugia*.

No. 191 to P. W. Bridgman, Harvard University, $500, for mechanical assistance in an investigation of various effects of high hydrostatic pressure, in particular the effect of pressure on electrical resistance of metals (continuation).

No. 192 to J. P. Iddings, Washington, D. C., $1,000, for apparatus and assistance in the microscopical and chemical investigation of igneous rocks for the purpose of extending knowledge regarding petrographical provinces and their bearings on the problem of isostasy.

No. 193 to C. A. Kofoid, University of California, $500, for assistance in securing animals in the Indian jungle and in their preparation for study in research on the intestinal protozoa.

No. 194 to R. A. Daly, Harvard University, $1,000, for the purchase of a thermograph of new design for determining temperatures in the deep sea.

No. 195 to R. W. Hegner, University of Michigan, $160, for assistance in the study of the history of the germ-cells, especially in hermaphrodite animals in order to determine the visible changes that take place in their differentiation and the causes of these changes (continuation).

The following information has been received concerning earlier grants:

No. 183. A report has been received from C. G. Abbot, describing the successful operation of the apparatus constructed with this grant. This closes the record of this award.

No. 184. Papers have been published by P. W. Bridgman on work done with the aid of this grant as follows: "Change of Phase under Pressure," *Physical Review*, N. S., VI., July and August, 1915. "Polymorphic Transformation of Solids Under Pressure," *Proceedings of the American Academy of Arts and Sciences*, II., September, 1915. This closes the record of this award.

The treasurer of the academy states, under date of April 7, 1916, that the Bache Fund has on hand a cash income balance of $980.62, together with an invested income of $2,575.

Respectfully submitted,

EDWIN B. FROST,
Chairman

REPORT OF THE COMMITTEE ON THE HENRY DRAPER FUND

Four members of the committee, without consulting the fifth member (Professor Michelson), recommended that the Henry Draper Gold Medal be awarded to Professor A. A. Michelson, of the University of Chicago, for his numerous and important contributions to spectroscopy and astronomical physics.

It is impossible in the brief space of this report even to enumerate Professor Michelson's major services to science. These include the precise determination of the velocity of light; the well-known experiment (with Professor Morley) on ether drift; the measurement of the absolute wavelength of light involved in his determination of the length of the standard meter; the measurement of tides in the body of the earth with new apparatus of extraordinary precision; and the invention of the interferometer, the echelon, and other instruments of prime importance to the student of light. He has also constructed a ruling machine yielding diffraction gratings of the longest size and the highest resolving power yet attained, and carried on a multiplicity of researches of wide range and fundamental significance.

The committee also recommends that a grant of $250 be made to Professor Philip Fox, director of the Dearborn Observatory, of Northwestern University, Evanston, Illinois, to apply toward the cost of a machine for measuring astronomical photographs.

Regarding previous grants from the Draper Fund, the committee begs to report that the grant to Dr. C. G. Abbot has been expended for computer's services in an investigation which has established the variability of distribution of radiation along the sun's diameter. Grants to Messrs. Campbell, Mitchell, Stebbins and Schlesinger, respectively, for the construction of instruments or the prosecution of researches not yet completed.

George E. Hale,
Chairman

REPORT OF THE TRUSTEES OF THE WATSON FUND

The balance of the income of the Watson Fund, available for appropriation, on April 1, 1916, was $1,070.15. The undersigned accordingly recommend the following votes:

Resolved, That the sum of five hundred dollars from the income of the Watson Fund be appropriated to Professor John A. Miller, director of the Sproul Observatory, for measuring plates already taken for the determination of stellar parallaxes. (Grant No. 10.) This is a continuation of Grant No. 10 awarded last year. A report of the work accomplished is enclosed.

Resolved, That the sum of three hundred dollars from the income of the Watson Fund be appropriated to Professor Herbert C. Wilson, director of the Goodsell Observatory, for measurements of the positions of asteroids on photographs already taken. (Grant No. 12.)

In each of these cases, material has already been collected whose preparation independently would involve a large expenditure. A relatively small sum will thus complete the work and secure the results for which the investigations were undertaken.

Edward C. Pickering,
W. L. Elkin,
Edwin B. Frost

REPORT OF THE COMMITTEE ON THE J. LAWRENCE SMITH FUND

The Committee on the J. Lawrence Smith Fund reports as follows:

No. 3. Edmund Otis Hovey, curator in the department of geology and invertebrate paleontology in the American Museum of Natural History, New York, received in 1909 a grant of $400 to aid in the study of certain meteors. He has for some time been with an expedition to the Arctic regions, so that the work is not at the moment making progress.

No. 4. C. C. Trowbridge, professor of physics in Columbia University, New York, received in 1909 a grant of $400 in aid of his studies of the luminous trains which are produced by some meteors. A further grant of $1,000 in four annual installments was voted by the Academy in 1912. Good progress has been made in the tabulation of all existing records of such luminous trains and in the preparation of illustrations of them, as well as in other directions. Owing to conditions in Europe the last installment of $250, available a year ago, has not yet been called for.

No. 5. George P. Merrill, head curator in the department of geology in the United States National Museum, has received grants in 1910, 1911 and 1913, amounting to $800, to aid in verifying the occurrence in some meteors of certain rare elements. This work has been very successfully completed, abstracts of results obtained have been presented to the academy, and the final report forms pages 1–26 of the *Memoirs* of the academy, Vol. 14, just issuing from the press, and closing the record of this grant.

No. 6. S. A. Mitchell, professor in the University of Virginia, University, Va., received in 1915 a grant of $500 to aid in securing observations of paths and of radiants of meteors and in computing orbits where observations are sufficient. Maps in aid of such observations have been placed at the service of volunteer observers, and nearly 5,000 observations of meteor paths have been secured. These observations, as well as a good number otherwise secured, have been discussed and have yielded some parabolic orbits.

The committee is unanimous in recommending that a further grant of $300 be made to carry on this valuable work.

The Lawrence Smith Fund now has a cash balance of income of $834.77 of which $250 is already appropriated, though not yet paid over. The cash income balance available is therefore $784.77. There is also an invested income balance of $1,532.50.

For the Committee,
EDWARD W. MORLEY,
Chairman

REPORT OF THE COMMITTEE ON THE COMSTOCK FUND

The committee on the Comstock Fund begs to report that, according to the statement of the treasurer of the National Academy of Sciences, the total income from the fund now available is $1,661.32.

The next award will be made at the end of the five-year period specified in the bequest, *i. e.*, at the annual meeting in April, 1918.

EDW. L. NICHOLS,
Chairman

April 18, 1916

REPORT OF THE DIRECTORS OF THE WOLCOTT GIBBS FUND

The directors of the Wolcott Gibbs Fund for Chemical Research respectfully submit the following report for the year 1915 to 1916 to the National Academy of Sciences.

On April 29, 1915, President Ira Remsen resigned from the board, to the great regret of his colleagues.

On May 18 Professor T. W. Richards was elected to fill the vacancy caused by President Remsen's withdrawal.

Only one appropriation has been made from the income of the fund this year—a grant (No. 6) to Professor Gregory P. Baxter, of Cambridge, of $300 to provide apparatus especially of platinum and quartz and materials for his researches on atomic weights and changes of volume during solution.

The unexpended income of the fund is $90.77.

Satisfactory reports have been received from holders of previous grants.

Grants 2 and 5. Professor Mary E. Holmes has a paper in press on "The Electro-Deposition of Copper from the Ammoniacal Cyanide Electrotype." Progress has also been made in the study of the deposition of cadmium and its separation from other elements.

Grant 3. Professor W. J. Hale has finished his work on the cyclopentadiopyridazine except for a few less important details. He hopes in June to have the paper ready for publication.

Grant 4. Professor W. D. Harkins has determined the freezing-point lowerings for thirteen salts in aqueous solutions, nine of which are cobaltammines; and has begun the study of mixtures of salts.

(Signed) C. L. JACKSON,
EDGAR F. SMITH,
T. W. RICHARDS,
Directors

April 6, 1916

REPORT OF THE COMMITTEE ON THE MURRAY FUND

SECRETARY, NATIONAL ACADEMY OF SCIENCES.

Sir: The Committee on the Sir John Murray Fund has to report that the unusual expenses due to the designing and striking off of the Agassiz medal, as called for by the terms of the gift, has required all the early income. The Committee deemed best not to touch the original fund, and the income from the fund was not sufficient to meet these expenses. All these expenses have now been met, but there is no cash balance and no invested income. This income has been applied to the payment of the amount advanced from the General Fund, but from now on the interest from the fund will be applied as originally intended, for the striking off of the Agassiz medal and contributions to oceanography.

ARNOLD HAGUE,
Chairman

REPORT OF THE COMMITTEE ON THE BILL, H. R. 528, TO DISCONTINUE THE USE OF THE FAHRENHEIT THERMOMETER SCALE IN GOVERNMENT PUBLICATIONS

Your committee for the consideration of Bill H. R. 528, consisting of Messrs. C. G. Abbot, S. W.

Stratton and C. F. Marvin, unanimously reports the following resolution, and moves its adoption.

The National Academy of Sciences shares the desire of scientific men in general for international and world-wide uniformity in units of measurement of all kinds, and with this object in view it favors the introduction of the Centigrade scale of temperature, and units of the metric system generally, as standards in the publications of the United States government.

It must be recognized that considerable initial expense must be incurred by the U. S. Weather Bureau in changing its apparatus to conform to the proposed act. Furthermore, on account of the more open scale of the Centigrade system that Bureau will be subject to a continued cost of publication, owing to the necessity of printing the first decimal place in order to maintain the present accuracy. The use of negative temperatures and minus signs entails greater liability to errors, and more clerical labor would be required in checking the accuracy of the reports of cooperative observers of the Weather Bureau, and in computing monthly and other mean temperatures.

Notwithstanding the foregoing, the Academy is in favor of legislation to make the Centigrade scale of temperatures the standard in publications of the United States government, and funds should be made available by Congress to accomplish the desired result.

The Academy favors Bill H. R. 528, "To discontinue the use of the Fahrenheit thermometer scale in government publications," but recommends that it be amended by the addition of the following:

Sec. 4. When in the publication of tables containing several meteorological and climatic elements, the use of data in Centigrade temperatures leads to manifest incongruities, the chief of the Weather Bureau is directed to publish related data in such units as are necessary to make the tables homogeneous and to secure international uniformity as far as practicable.

Sec. 5. Nothing in this act shall prevent the use of the absolute Centigrade scale of temperature in publications of the government.

Upon recommendation of the Council the following minute was adopted:

That in accordance with the request of the chairman of the Committee on Foreign Affairs of the House of Representatives a committee of the Academy be appointed to prepare a report upon the joint resolution (H. J. Res. 99), "That the President be, and he is hereby, requested to ascertain the views of foreign governments regarding the proposition to appoint an international commission to prepare a universal alphabet," and that the report be submitted to the president of the academy, who in turn will transmit it to the chairman of the Committee on Foreign Affairs of the House of Representatives, reporting his action in the matter at the next annual meeting of the Academy.

Messrs. Cattell, Bell, Boas, Dewey and Lindgren were appointed members of this committee.

The council also recommended to the academy the appointment of a committee to discuss possible plans of cooperation with a committee of engineers. The following committee was appointed: George E. Hale, chairman, J. S. Ames, John F. Hayford, E. L. Nichols, M. I. Pupin, E. B. Rosa, Elihu Thomson, C. R. Van Hise, C. D. Walcott, R. S. Woodward.

The president announced that an invitation had been received from the members of the Academy living in Boston that the Academy hold its autumn meeting in the year 1916 in that city. The following members were appointed to serve as a local committee of this meeting: William M. Davis, chairman, W. T. Councilman, Arthur A. Noyes, George H. Parker, E. C. Pickering.

Mr. George E. Hale was reelected foreign secretary of the academy for a term of six years.

Mr. R. H. Chittenden and Mr. M. I. Pupin were elected members of the council for a term of three years.

New members of the academy were elected as follows:

Gilbert Ames Bliss, University of Chicago, Chicago, Illinois.

Frank Schlesinger, University of Pittsburgh, Pittsburgh, Pa.

Gregory Paul Baxter, Harvard University, Cambridge, Mass.

Marston Taylor Bogert, Columbia University, New York City.

Leland Ossian Howard, U. S. Department of Agriculture, Washington, D. C.

Alfred Goldsborough Mayer, Carnegie Institution, Tortugas, Florida.

Raymond Pearl, Maine Agricultural Experiment Station, Orono, Maine.

Phoebus Aaron Theodor Levene, Rockefeller Institute for Medical Research, New York City.

Otto Folin, Harvard Medical School, Boston, Mass.

Arthur L. Day,
Home Secretary

SCIENCE

FRIDAY, MAY 12, 1916

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THE ONE-HUNDREDTH ANNIVERSARY OF THE UNITED STATES COAST AND GEODETIC SURVEY

ACCOUNT OF THE CELEBRATION

IN eighteen hundred and sixteen the United States Coast Survey was organized under Mr. Ferdinand Rudolph Hassler, as superintendent, and field work was begun.

This event was fittingly celebrated in Washington on the fifth and sixth of April last by public meetings in the auditorium of the New National Museum at Washington at which papers were presented by representative men in the fields of science, engineering, commerce, government and military affairs.

The celebration closed with a banquet at the New Willard Hotel, the evening of the sixth, at which the President of the United States was the principal speaker. The other banquet addresses were by the Secretary of the Navy, the Secretary of Commerce, the minister of Switzerland, and former superintendent of the Survey, Dr. T. C. Mendenhall.

The superintendent of the Survey, Mr. E. Lester Jones, presided at the banquet and at the three public sessions at the museum. He opened the session with well-chosen remarks and was followed by Mr. Redfield, Secretary of Commerce, the department of which the Survey is a bureau. Mr. Redfield paid a tribute to the valuable work done by the members of the Survey during the hundred years of its existence. He made a plea for support from the public and from Congress in order that the Survey might greatly extend its usefulness to the science, industries, commerce and defense of the nation.

The program of papers presented at the general sessions was given on page 421 of Science of March 24, 1916. The paper by Admiral Pillsbury was read by title only, as he was ill and not able to appear. Each of the papers presented some particular phase of the survey's activities and in a number of cases there was shown how its work was related to that of some of the other organizations of the government.

The address by President Wilson at the banquet, the paper of Dr. George Otis Smith and abstracts of the other papers and addresses follow this brief account of the celebration.

A very interesting feature of the celebration was an elaborate exhibit of the instruments, charts and publications of the survey, some of them dating back to the earliest years of its history. A series of enlarged photographs showed in a very clear and impressive way the modern field operations of the survey.

The proceedings at the celebration, including the addresses delivered, will be published in one volume by the survey.

William Bowie

ADDRESS OF THE PRESIDENT OF THE UNITED STATES

Mr. Minister, Mr. Superintendent, Ladies and Gentlemen: I had another reason for asking to come last. I remember reading with appreciation in the preface of a volume of essays written by a very witty English writer a passage to this effect: The pleasure with which a man reads his own books is largely dependent upon how much of them has been written by somebody else; and I have found that my enjoyment of making speeches after dinner is almost directly in proportion to the amount of inspiration that I can derive from others.

It was manifestly impossible for me to make such preparation for addressing you to-night as I should have wished to make in order to show my very great respect and admiration for this service of the government. I can only say that I have come here for the purpose of expressing that admiration. I have been very much interested in the speeches that I have heard to-night, not only because of what they contained, but also because of many of the implications which were to be drawn from them. I was very much interested indeed in the excellent address of the representative of the free and admirable republic of Switzerland. He reminded us of what we must constantly remember, our very great intellectual debt to Switzerland, as well as to the many other countries from which we draw so much of our vitality and so much of the scientific work which has been accomplished in America.

As he was speaking, I was reminded (if there are Pennsylvanians present, I hope they will forgive this story) of a toast mischievously offered at a banquet in Philadelphia by a gentleman who was not himself a Pennsylvanian. He said he proposed the memory of the three most distinguished Pennsylvanians, Benjamin Franklin, of Massachusetts; James Wilson, of Scotland, and Albert Gallatin, of Switzerland. I dare say that in many American communities similar toasts could very truly and with historical truth be offered. And I myself had the privilege of sitting under one of the distinguished Swiss scholars to whom reference was made, Dr. Arnold Guyot, under whom I pretended to study geology. Doctor Guyot was not responsible for its not being carried beyond the stage of pretence.

I feel myself in a certain sense in familiar company to-night, because a very great part of my life has been spent in association with men of science. I have often wished, particularly since I entered public life, that

there was some moral process parallel to the process of triangulation, so that the whereabouts, intellectually and spiritually, of some persons could be discovered with more particularity. Yet as I listened to the Secretary of Commerce, I suspected that he was priding himself upon the discovery of a process by which he had discovered the whereabouts of a great many committees of Congress and a great many other persons connected with the process of appropriating public moneys. I have a certain sympathy with those committees of Congress which in investigating the Coast and Geodetic Survey have found that the superintendent had the great advantage of knowing all about the service and they the great disadvantage of knowing nothing about it, because, as I have said, I have spent a great part of my life in association with men of science and, never having been a man of science, I have at least learned the discretion of keeping my opinions on scientific subjects to myself.

I have had association particularly with the very exact and singularly well informed brother of a distinguished gentleman present. General Scott has a brother who is a member of the faculty of Princeton University, and Professor William B. Scott is one of the most provoking men I have ever known. He not only asserts opinions and delivers himself of information upon almost every subject, but the provoking thing about him is he generally knows what he is talking about. A good talker who volunteers opinions on all subjects ought to be expected in fairness to his fellow men to make a certain large and generous portion of mistakes, because you can at least catch him napping, but Professor Scott is one of those men who successfully—I have sometimes told him I suspected adroitly—avoided the pitfalls of eminent conversationalists like himself; but association with such men has taught me a very great degree of discretion and, therefore, I am not going to express any opinion whatever about the work of the Coast and Geodetic Survey. But I am going to give myself the privilege, for it is a real privilege, of saying this:

This is one of the few branches of the public service in which the motives of those who are engaged can not be questioned. There is something very intensely appealing to the imagination in the intellectual ardor which men bestow upon scientific inquiry. No social advantage can be gained by it. No pecuniary advantage can be gained by it. In most cases no personal distinction can be gained by it. It is one of the few pursuits in life which gets all its momentum from pure intellectual ardor, from a love of finding out what the truth is, regardless of all human circumstances—as if the mind wished to put itself into intimate communication with the mind of the Almighty itself. There is something in scientific inquiry which is eminently spiritual in its nature. It is the spirit of man wishing to square himself accurately with his environment, not only, but also wishing to get at the intimate interpretations of his relationship to his environment; and when you think of what the Geodetic Survey has been attempting to do—to make a sort of profile picture, a sort of profile sketch, of the life of a nation, so far as that life is physically sustained—you can see that what we have been doing has been, so to say, to test and outline the whole underpinning of a great civilization, and just as the finding of all the outlines of the earth's surface that underly the sea is a process of making the pathways for the great intercourse which has bound nations together, so the work that we do upon the continent itself is the work of interpreting and outlining the conditions which surround the life of a great nation.

I can illustrate it in this way, the way in

which it appeals to my imagination: I have always maintained that it was a great mistake to begin a history of the United States intended for beginners by putting at the front of the book a topographical map of this continent, or at any rate of that portion of it which is occupied by the United States, because if you begin with that, you seem to begin to deal with children when you deal with the first settlers. They know nothing about it. They expected to find the Pacific over the slope of the Alleghanies. They expected to find some Eldorado at the sources of the first great river whose mouth they entered upon the coast. They went groping for the outlines of the continent like blind men feeling their way through a jungle. They were as big men as we, as intelligent; they had as full a grasp upon the knowledge of their time as we have upon the knowledge of ours; but set the youngster in the school to watch these men groping, and he will get the impression that they were children and pygmies. That is not the way to begin the history of the United States. You will understand it only if you comprehend how little of what the work of this department of the government, for example, has since disclosed, was known to those then engaged in this great romantic enterprise of peopling a new continent and building up a new civilization in a new world.

So that you have the picture of a service like this lifting the curtain that before that time rested upon all the great spaces of nature. You remember how in the early history of Virginia a little company of gentlemen moved by a sort of scientific curiosity, and yet moved by a spirit of adventure still more, penetrated no further than to some of the unknown fastnesses of the Alleghany Mountains and were thereafter known as the Knights of the Golden Horseshoe—given a sort of knighthood of adventure because they went a little way upon the same quest upon which you gentlemen have gone a great way.

So when I stand in the presence of scientific men I seem to stand in the presence of those who are given the privilege, the singular privilege, the almost contradictory privilege, of following a vision of the mind with open, physical eyes; making real the things that have been conjectural; making substantial the things that have been intangible.

And as the Secretary of Commerce has said, there is a great human side to the things that you are doing. You are making it safe to bind the world together with those great shuttles that we call ships that move in and out and weave the fabric of international intercourse. You are providing the machinery by which the web of humanity is woven. It is only by these imaginative conceptions, it is only by visions of the mind, that we are inspired. If we thought about each other too much, our little jealousies, our rivalries, our smallnesses, our weaknesses, there would be no courage left in our hearts.

Sometimes when the day is done and the consciousness of the sordid struggle is upon you, you go to bed wondering if the sun will seem bright in the morning, the day worth while, but you have only to sweep these temporary things away and to look back and see mankind working its way, though never so slowly, up the slow steps which it has climbed to know itself and to know nature and nature's God, and to know the destiny of mankind, to have all these little things seem like the mere mists that creep along the ground, and have all the courage come back to you by lifting your eyes to those blue heavens where rests the serenity of thought.

THE UNITED STATES GEOLOGICAL SURVEY AND ITS RELATION TO THE UNITED STATES COAST AND GEODETIC SURVEY[1]

THE relations of near relatives may be a delicate subject for public discussion. The two organizations of which I have been asked to speak this afternoon possess the same family name as well as certain family characteristics and in consequence are often mistaken one for the other. If one Survey buys a motor truck the other gets the benefit of the advertising and the curious public remarks: "We don't see how the Geological Survey can afford it."

Yet the relations of the two Surveys have been such for more than a third of a century, and are such to-day, that I welcome this opportunity for the younger to extend congratulations to the older organization. Were I to review in detail the common history of these two Surveys there are no chapters that I should better omit nor incidents that I might need to gloss over in order that my remarks be in keeping with the spirit of this occasion. In short, the hearty congratulations that I bring are an expression of true appreciation of what the United States Coast and Geodetic Survey has been to the United States Geological Survey.

The two bureaus have much in common; the field of endeavor for each is nation-wide; they are scientific in spirit and civil in organization; both are primarily field services, and the product of most of the work of each reaches the public in the form of maps. The similarity in official name also indicates a certain overlapping of function, which under some conditions might cause duplication of work. The fact that at no point in the twilight zone of superimposed jurisdiction has there been any wasted effort is good evidence that both these branches of the federal scientific service have kept in mind the public nature of their work. It is because I realize that in the interrelations of these two bureaus the Geological Survey has been more often the beneficiary that I desire on this occasion to emphasize this gratifying fact that the two Surveys have worked in the cause of American science on a coordinated rather than a competitive basis.

In this connection I should mention the effort made thirty-seven years ago to put on an economic and efficient basis the surveying work in the Western States. Under instructions by Congress the National Academy of Sciences considered all the work relating to scientific surveys and reported to Congress a plan prepared by a special committee, whose membership included the illustrious names of Marsh, Dana, Rogers, Newberry, Trowbridge, Newcomb and Agassiz. This report, which was adopted by the academy with only one dissenting vote, grouped all surveys, geodetic, topographic, land-parceling and economic, under two distinct heads—surveys of mensuration and surveys of geology. At that time five independent organizations in three different departments were carrying on surveys of mensuration, and the academy recommended that all such work be combined under the Coast and Geodetic Survey with the new name Coast and Interior Survey. For the investigation of the natural resources of the public domain and the classification of the public lands a new organization was proposed—the United States Geological Survey. The functions of these two Surveys and of a third coordinate bureau in the Interior Department, the Land Office, were carefully defined and their interrelations fully recognized and provided for in the plan presented to Congress. Viewed in the light of thirty-seven years of experience, the Na-

[1] Centennial exercises of the U. S. Coast and Geodetic Survey, April 5, 1916.

tional Academy plan would be indorsed by most of us as eminently practical, and I believe the report stands as a splendid example of public service rendered by America's leading scientists. The bill which embodied the entire plan, however, failed of passage in Congress, although the part relating to the organization of the new Geological Survey was carried as a rider on the Sundry Civil Appropriation Act of March 3, 1879.

The newly organized United States Geological Survey began topographic surveys of the type that the National Academy had believed could best be executed by the Coast and Geodetic Survey, and the younger Survey has continued this kind of mensuration surveying until it has covered more than 40 per cent. of the country and become the principal map-making bureau of the government. In course of time also more or less legislative authority has been given for the control work, vertical and horizontal, needed for these topographic surveys, so that there has been evolved exactly the opportunity for duplication of work that the National Academy sought to prevent. The invitation to speak this afternoon on the subject of the relation of the United States Geological Survey to the United States Coast and Geodetic Survey is a privilege that I value highly because it gives me the opportunity to point out that the result that Congress failed to insure by legislation has been attained by voluntary scientific cooperation.

In topographic mapping the activities of the older bureau stop at the coast, as its name suggests; its mensuration surveys elsewhere are purely geodetic and represent a refinement of method and an accuracy of result that is not necessary in the ordinary mapping of the country as a whole, although these engineering results are absolutely essential. Members of the Geological Survey most familiar with these large contributions by the Coast and Geodetic Survey have estimated that the value of the geodetic work done by the older organization that would otherwise have necessarily been done by the Geological Survey has aggregated not less than a million dollars, and if the future engineering work of the Coast and Geodetic Survey as now planned is carried to completion another million dollars should be included in our total indebtedness to the older Survey.

The United States Geological Survey is proud of its pioneer work in aid of the development of the resources of Alaska, yet we are not forgetful of the fact that the real pioneer in Alaska was the United States Coast and Geodetic Survey, which started its work in Alaska thirty years earlier than our own Survey.

It has been the custom of each of these Surveys to supply the other with photographic copies of field sheets of current work, and I am glad to record the fact that cooperation of this type has not been one-sided. Our topographic survey of the Bering River coal fields, for instance, yielded data that were incorporated in the important Coast Survey chart of Controller Bay, which was published before the Geological Survey issued its topographic map of the larger area. In this way the public was served by receiving the information earlier than if the Geological Survey had insisted upon first publishing its own results. The testimony of the members of the Alaskan division of the Geological Survey is that the cooperation in Alaska has been as hearty and close as if the Coast and Geodetic Survey men and the Geological Survey men belonged to the same bureau.

In this connection too should be mentioned the earlier geologic observations made in Alaska by members of the Coast and Geodetic Survey, and chief among

these scientist pioneers in Alaska is our own Dr. Dall, the credit for whose half century of scientific work under government auspices is shared by the Coast and Geodetic Survey and the Geological Survey. In connection with its engineering work also, the Coast and Geodetic Survey has made important scientific contributions that are distinctly geologic in character, and as geologists we are almost inclined to lay claim to Hayford's work on isostasy and Bowie's gravity determinations.

Every geologist who works in that attractive borderland where both the products of geologic processes and the processes themselves can be studied side by side—our Continental shore line—has made large use of the Coast and Geodetic Survey charts, and as competent witnesses we gladly testify to the accuracy of these charts and we compliment their makers. Such geologic investigations as the study of changing shore lines, the history of the submerged margins of the continent, and the origin of sediments are being given attention by the Geological Survey, and all these studies must be based upon the surveys and resurveys made by the Coast and Geodetic Survey.

This brief review of the relations existing between these two bureaus may serve a larger purpose than the sincere expression of congratulations to the Coast and Geodetic Survey on this centennial occasion. For nearly four decades these two Surveys have been working side by side from Florida to Alaska without the specific statutory separation of functions deemed advisable by the National Academy and therefore with full opportunity to overlap their fields of operation, to duplicate work, and thus to waste public money. The fact that there has resulted economical coordination rather than wasteful competition stands to the credit of those in administrative control of the two bureaus, especially the superintendents and directors of the earlier years of this period of successful cooperation. Naturally too the spirit of hearty cooperation is equally shown between the scientific assistants of the two services.

In these days, when as American citizens we have so deep concern in the question of public regulation of private business—a nation-wide concern arising from a broadening appreciation of society's interest in the individual—it may be opportune for some of us as public officials to pause and consider the question of regulation of public business. Do we apply the same rules to our conduct of the business of these federal bureaus that we advocate for the control of corporations? Some of us as scientists may feel that the comparison of a scientific bureau with an industrial corporation is forced if not absurd. Yet I trust that the two are alike in being not only productive but productive without undue waste. The National Academy report of 1878 to which I have referred contains a significant phrase: in presenting to Congress the ideal for a scientific bureau as they saw it these scientists described the ideal plan as one that would yield the "best results at the least possible cost." Those few words express a practical administrative policy equally good for big business and pure science. And it is as illogical for a scientific bureau as for a munitions plant to shy at a cost-keeping system.

Here at the federal capital we have some two score scientific bureaus distributed through several executive departments. There exists no general plan of division of duties among these different agencies for public service, but as a fundamental policy we have pinned our faith to a sort of declaration of independence that all scientific bureaus were created free and equal. My acquaintance with bureau chiefs and their intimate advisers perhaps warrants

me in describing them as possessing at least average ambitions, with the inevitable result that we have seen some field of scientific investigation occupied by two or more bureaus, other and less attractive fields shunned, and even other fields claimed by those bureaus not best qualified to make the largest use of the opportunity for creative work. Among ourselves, we know of so many illustrations that no examples need be cited; each of us no doubt feels sure that he can at least specify the sins of other bureaus. This is the competitive system almost at its worst, because it is countenanced by men of scientific training and high ideals of public service. Fortunately, however, the two bureaus of which I have particularly spoken, as well as some others, furnish proof that there can be coordinated effort in federal scientific work.

I have here referred to the business world, because I believe we must apply some of the same rules to our scientific work. However slight may be the statutory limitations imposed by Congress upon these scientific bureaus, we can not escape the requirements of economic law, which is never a dead letter, although too often unread. If in the world of private business the competitive system sometimes breaks down and fails to protect the public, so in our narrower circle of public business there may be a similar failure of competition to produce the best results. The question is always fair and is sometimes pertinent, How far should these government scientific bureaus go in seeking to enlarge their field of usefulness? Does this competitive spirit by its appeal to individual ambitions make for better public service? To what extent is it good public policy to have the public servants on the *qui vive* for new opportunities to serve, new worlds to discover, new appropriations to get? Service and discovery are the proper ideals of the individual investigator, but should even ideals justify trespass and disregard of others?

First of all, we must agree that however great its advantage as a method of stimulating progress, competition must be always fair. If we are to apply the principles of the Sherman Act and the Clayton Law to public business, unfair methods must be ruled out as illegal. I do not believe my comparison is a forced one. You can read decrees of the federal courts that prohibit corporations from doing things that are somewhat similar to practises of which we ourselves have been guilty. In one case, among other items, the defendant corporation was enjoined from making false representations concerning competitors and from hiring away employees of competitors—simply a twentieth-century echo of the ninth and tenth commandments of the Mosaic law, especially the edict against coveting thy neighbor's man-servant. In the public service proper coordination of work often makes transfers from one bureau to another desirable, and so as a means of increasing efficiency such transfers are and should be welcomed, but efficiency from the larger view is attained only when the interests of both bureaus are considered, in which event the individual also profits by his larger opportunity. With science alive and expanding in so many directions, subdivision and redistribution of functions makes certain interbureau transfers of specialists absolutely necessary.

Another unfair practise, not countenanced by the courts in their regulation of private business, is tricky advertising as a method of meeting real competition. Honest advertising must be founded on truth, and even scientific bureaus may need sometimes to apply this acid test to the statements they give out to the public. Scientific investigations whose purpose is to increase human knowledge do not find their

best expression in publicity whose principal object is to impress the Appropriation Committee. Such advertising may have its foundation in truth and yet may possess a superstructure so large and top-heavy as to violate all engineering formulas.

Unrestrained competition in the public service, then, presents some dangers no less real than those incident to unregulated competition in private business. The question must come home to every bureau chief and to his intimate advisers: To what extent is a competitive struggle for new territory warranted, even when only fair methods are used in this endeavor for bureaucratic expansion? I am aware that we may invoke "the public demand" and put forward other equally plausible reasons, but even if we sometimes fool Congress and on rare occasions fool each other, we never fool ourselves. Of course the individual investigator, self-centered with enthusiasm in his discovery of a new line of research, may be wholly ignorant of the fact that among the two thousand or so fellow scientists here in Washington, some one in another department has already preempted that subject and possibly carried the work well on to completion; but however unconscious the scientific worker in one bureau may be of the obvious relation of that problem to the work of some other bureau, only rarely indeed can his own bureau chief plead any such ignorance or innocence. May I express my individual conviction that the bureau chief who makes strategic moves in this contest for enlargement of field of work is just as conscious whether he is playing the game fairly as the "captain of industry" that we have thought ought to be investigated by the Department of Justice.

Even at its best, however, this competitive system is wasteful. The public has too often found that competition as the safety-valve of business costs too much in steam. If in the branch of public business in which we are engaged the ideal is to render the best service at the lowest cost, must there not be regulation, and regulation which recognizes that there are what we may term natural monopolies in the government scientific service? The monopolistic idea must here yield the same real savings to society that have come with the recent growth of public-utility monopolies. The product of our scientific bureaus is not a staple commodity, but a special service to the public, and under governmental auspices this service is offered without price, yet that does not mean that we are any less vitally interested in costs. If monopoly will enable these scientific bureaus to render the best service at the lowest cost, the competitive system in scientific work should go to the scrap heap as out of date.

The adoption of the monopoly system, however, involves here, as in the field of public utilities, the correlative idea of adequate regulation in the public interest. And here is where we may be in danger of losing our way, for the question of course obtrudes itself: Who is the guide; who is to define the field of work to be monopolized by this or that bureau? My own belief is that Congress can not be expected to enforce even its own wishes in the matter. Some years ago the chairman of a Congressional committee that had made a most thorough investigation of one of the departments, himself a trial lawyer of large experience, admitted to me that the investigation had been largely in vain; in his own words, "I know the department is full of duplication, but it would take a trained scientist to put his finger on it all." Nor can the cabinet officer be expected in a few years to discover all the overlaps in his own department, much less to learn the logical and proper coordination of the scientific

work in several departments. Thus the responsibility in large measure falls back upon the bureaus themselves—they must provide that careful coordination which precludes wasteful competition and promotes helpful cooperation. To return for a moment to my text, I do not know that the successful coordination of the work of our two Surveys has been due in any large degree to the influence of Congress, although my experience is that appropriation committees do watch these details, nor have I ever known any Secretary of the Interior or of the Treasury or of Commerce to define this wise policy; the happy result must be credited rather to a small group of administrative chiefs in each of these two scientific bureaus.

The obligation for the proper conduct of the scientific work of the government, therefore, can not be lifted from the shoulders of the bureau chiefs and their immediate associates in the work of administration. Moreover, this responsibility is a double one —we should feel not only the duty as public servants to avoid wasteful use of the public money, but also the obligation as scientists to conserve scientific effort by preventing duplication in research and in publication. Aside from the absurdity that lies in the spectacle of bureau chiefs trying to impress congressional committees, do we not by our acts suggest a lack of faith in science itself? We talk impressively of the day of highly specialized science and then go out and poach on what is properly the domain of others. Since the days of Aristotle students of politics have recognized as a weakness in democracies the habit of not appreciating the value of trained specialists. Within a few weeks the *London Financial News* remarked editorially upon the national neglect of science to which is now attributed the bulk of the British failures under the test of war. But as self-labeled scientists are we not ourselves similarly lacking in our appreciation of the value of science and of scientific organization in so far as we fail to recognize that by reason of its experience and its personnel some other bureau, even in another department, can better handle a certain subject than our own bureau. Especially when a new idea is before the public are we apt to be temporarily blinded by its popularity and thus lose sight of the eternal fitness of things. I can best illustrate this by mention of a current topic. The fixation of nitrogen is a matter of national importance; plainly the military departments are most concerned by reason of their need of nitric acid for munitions, yet as against any claims of the War and Navy Departments must be set the fact that nitrogen is one of the essential elements in fertilizers, and its production is therefore of vital concern to the Department of Agriculture; however, the mineral deposits necessary to the fixation process are to a large extent under the jurisdiction of the Department of the Interior, not to mention some of the most available power sites; nor must I overlook the fact that this subject was first investigated and reported upon by a bureau in the Department of Commerce. So the competitive contest is on, but the obviously most reasonable consideration is still in the background. What department or bureau, if any, has already on its rolls the force of hydraulic and construction engineers ready to begin the preliminary studies and surveys and the organization already adapted to push the construction of the plant, should Congress authorize this innovation in governmental activity? As evidence of my good faith in mentioning this illustration, let me add that an investigative bureau like the Geological Survey is not organized on a plan at all adapted to the construction and operation of an industrial plant; and all that I may

claim for our bureau in this connection is that we sometimes recognize the obvious.

Those of us who have been responsible for the work of securing the needed appropriations are at times likely to have our judgment warped by what we think are the exigencies of the case. A member of a scientific bureau was once so concerned for the success of his bureau that he even recommended its transfer to another department so as to get under the wing of a more generous appropriation committee. The logic of the situation does not always appeal to us, and we are willing for the moment to sell our birthright for a larger appropriation. The obvious fact in this matter of the interrelations of the scientific bureaus of the government is that if the bureau chiefs do not always exhibit an appreciation of the proprieties in scientific investigation nor seem to possess much idea of perspective in the alignment of boundaries, can even the most experienced legislators be expected to make the best distribution of scientific work?

The possession by any bureau of even a skeleton organization of efficient specialists in a certain field would seem to be the practically unanswerable argument for entrusting to that bureau any new and enlarged work in that field whenever Congress deems larger appropriations advisable. That is the type of practical logic that is recognized in private business, for under public regulation of natural monopoly the public-utility company that first enters the local field is recognized and even protected by the public-service commission, as long as the service rendered is at all adequate. In the business world the day of preferment of special applicants in the granting of municipal franchises has passed, and in our government business there is no better reason for granting special privileges to overzealous bureau chiefs. I sometimes think that the bureau chief comes nearer being safe and sane in his public acts and utterances in the intervals between sessions of Congress.

In this informal comparison of the actual and the ideal in the administration of the scientific bureaus of the government, I have had ever in mind the existence of a real basis for optimism in the splendid record of the Coast and Geodetic Survey and the Geological Survey in absolutely coordinating their endeavors in the public service. And I desire simply to add that this practical cooperation has been so easily accomplished that it is only as we review these several decades of joint work and estimate the value of the reciprocal services rendered that we realize how ideal have been the relations between the two Surveys.

GEORGE OTIS SMITH
U. S. GEOLOGICAL SURVEY

ABSTRACTS OF ADDRESSES AT THE CENTENNIAL EXERCISES OF THE U. S. COAST AND GEODETIC SURVEY

APRIL 5, 1916

The Bureau of Fisheries and Its Relation to the United States Coast and Geodetic Survey: DR. HUGH M. SMITH.

Long before the Coast and Geodetic Survey and the Bureau of Fisheries were adopted by the same mother department and thus became sisters; in fact as early as 1873, when the former had already attained a robust maturity and the latter was still in swaddling clothes, there began close cooperative relations. These have continued up to the present time and have increased in intimacy and value in more recent years since the two establishments became members of the same official family. It is only fair to acknowledge that at first the cooperation was very one-sided, consisting largely of the bestowal by the Coast and Geodetic Survey of substantial favors in return for profuse thanks. From 1880, when the Bureau of Fisheries began to acquire vessels of its own, that service began to repay, in part at least, some of its obligations, and ultimately it contributed substantially to the published records of the Survey. The former has always depended on the latter for its

basic triangulation whenever a biological survey of any kind has been undertaken in a region in which the Coast Survey has operated, which of course means anywhere on the coast of the United States. On the other hand, the hydrographic and topographic results of this biological work have always been made available to the survey.

On both the Atlantic and Pacific coasts a considerable part of the offshore soundings found on the charts was determined by the steamers *Fish-Hawk* and *Albatross* in pursuance of their fishery investigations, and some of the inshore data of certain of the earlier charts came from reconnoissances by the *Albatross*. While much of the latter has been superseded by more accurate work as the Coast Survey was able to extend its operations, it served a good purpose for some years. Later there came into the command of these two vessels naval officers who had been trained in the survey, with resulting improvement in the character and accuracy of the fishery surveys, not only those under their immediate direction, but throughout the service. I can not let this opportunity pass without paying humble tribute to the distinguished labors in behalf of oceanic physics and biology performed by men like Z. L. Tanner and J. F. Moser, who, while retaining their naval status, commanded fishery vessels, and collected invaluable material for the Coast Survey.

The gathering of hydrographic and other data for use of the Coast and Geodetic Survey by the steamer *Albatross* has been particularly extensive in the Pacific Ocean and along the west coast of America.

Work Done by the United States Coast and Geodetic Survey in the Field of Terrestrial Magnetism: Dr. L. A. Bauer.

From the earliest days of the establishment of the Coast Survey, magnetic observations for the prime use of the surveyor and of the mariner were considered a legitimate and useful part of its work. In the "Plan for the Reorganization of the Survey of the Coast," as adopted in 1843, explicit provision was made for the making of "All such magnetic observations as circumstances and the state of the annual appropriations may allow." Since then Congress, by annual appropriations, has continuously and increasingly recognized the importance of this feature of the work of the survey, so that in 1899 an enlarged appropriation made it possible to carry out a magnetic survey of the whole United States on a systematic basis, and with an expedition theretofore not possible.

When the first chart of the lines of equal magnetic declination, known to the surveyor and the mariner as the lines of equal variation of the compass, was issued by the Coast Survey in 1855, the number of available stations at which magnetic observations had been made amounted to about 150, and these were distributed very irregularly and covered but a limited region of our country. At the close of 1915 the number of these stations was 5,000, the stations now being distributed fairly uniformly over the United States. Besides, a vast amount of magnetic data has been compiled from other sources and the survey has also made magnetic observations at some 500 stations in our outlying possessions. The average distance apart of the places at which accurate magnetic observations have now been made in the United States is about 25 miles. Meridian lines for the use of surveyors have been established at many county seats throughout the country, magnetic data at sea have been accumulated on cruises of the Coast Survey vessels, and five magnetic observatories, where the countless fluctuations of the earth's magnetism are being continuously recorded, are at present in operation under the direction of the survey.

The contributions of the Coast and Geodetic Survey to the advancement of our knowledge in terrestrial magnetism, in fulfilment of both practical and scientific demands, have been unexcelled by any other national organization. Because of its extensive compilations of data relating to the change of the compass direction from time to time, the Coast and Geodetic Survey is able to furnish promptly information of priceless value in the adjudication of disputed land boundaries, the bearings of which were referred to the compass direction when originally laid out, 100 to 150 years or more ago.

The changes in the compass direction reach very appreciable amounts with the lapse of time. The compass even changes its direction between morning and afternoon by an amount appreciable in accurate land surveying. During a so-called magnetic storm, the compass direction may change suddenly by a degree or more. All such fluctuations are recorded at the magnetic observatories of the survey, and the information is published promptly, and made readily accessible to all interested.

The assumption frequently made by surveyors that the compass has changed its direction regularly at the rate of 3 minutes per year or 1 degree in 20 years, is not borne out by the data of the survey. At the present time, for example, in the New England states the north end of the com-

pass is moving west at the rate of about 6 minutes per annum. In Porto Rico this westerly motion is as much as 10 minutes, and along the northeastern coast of Brazil it is about 16 minutes. Thus, instead of a change of 1 degree in 20 years, there may be a change of 1 degree in 10 years or even in 5 years or less, depending entirely upon geographic location.

The Bureau of Standards and its Relation to the United States Coast and Geodetic Survey: DR. S. W. STRATTON.

The speaker sketched the history of the various standards which have been used in this country. He paid a high tribute to Mr. Hassler for creating the division of weights and measures of the survey. This division became in 1904 the present Bureau of Standards, a separate organization. He spoke of the close cooperation which has always existed between the Bureau of Standards and the Coast and Geodetic Survey.

Ocean Currents and Deep Sea Explorations of the United States Coast and Geodetic Survey: REAR ADMIRAL J. E. PILLSBURY.

After mentioning the early voyagers who came in contact with and noticed the Gulf Stream, a brief description was given of the first American investigation, that of Benjamin Franklin. On his voyages to and from Europe—and there were many—he observed the temperature of the water in the endeavor to determine the northern limit of the stream issuing from the Straits of Florida under the theory that the warmer water indicated its boundary.

It was not until 1845 under the administration of A. D. Bache that the Coast Survey began a systematic study of the Gulf Stream. From that year until 1853 many vessels were engaged in the work under the most comprehensive orders. They were to determine its limits, surface and subsurface, whether constant or variable, whether depending upon winds and how recognized, whether by temperature, soundings, vegetable or animal life, specific gravity of its water, etc.

In 1867 Professor Henry Mitchell, of the Coast Survey, began an investigation of the Gulf Stream by a new method. He sounded between Key West and Havana and observed currents to 600 fathoms by means of floating cans, or weighted cans suspended from floating cans.

The survey also used ballasted bottles to determine the course of the currents. Each one when it was put overboard contained a paper with a request to the finder to send it to some American official and to mark on it the place where it was found.

In 1883 the first attempt was made to investigate the actual flow of the Gulf Stream by a vessel at anchor, when the schooner *Drift* under Lieutenant Fremont anchored with wire rope and observed the currents between Jupiter Inlet, Florida, and Memory Rock, Bahama.

The results were of so great value that the Superintendent decided to continue the work, but the use of a sailing vessel for the purpose was considered impracticable. The time spent in reaching the anchorage and the hours required in anchoring and in getting under way by the use of hand power alone necessitated the selection of a vessel with steam for the purpose. The *Blake,* under Lieutenant Pillsbury, was the vessel chosen, and during the following five years she was engaged in Gulf Stream work each winter season and some summers. Anchorages were made in any depth required; many being in water deeper than 1,500 fathoms, and the deepest in 2,300 fathoms. The longest time at any one station was about seven days, and by the use of an instrument devised for registering the direction as well as the velocity of the currents, observations were carried on as long as the vessel remained at anchor.

As to results, it was found that the velocity of the Gulf Stream varied daily, according to the moon's transit, and monthly following its declination, and that these variations could be predicted with fair accuracy. A calculation as to its volume, deduced from many hundreds of observations in the narrowest part of the Straits of Florida, gave 90,000,000,000 tons per hour.

The United States Geological Survey and its Relation to the United States Coast and Geodetic Survey: DR. GEORGE OTIS SMITH. Printed in this issue of SCIENCE.

The United States Coast and Geodetic Survey's Part in the Development of Commerce: HON. J. HAMPTON MOORE.

Mr. Moore spoke of the relation of the Coast and Geodetic Survey to Commerce and after paying high tribute to the perseverance and loyalty of the men of the service, said that commerce itself did not fully appreciate the importance of the work. Amongst other things, he referred to the formation of shoals and the location of rocks that impede navigation.

"I am interested in the safety of life and commerce on all our coasts, but by reason of familiarity with the Atlantic coast, I may be pardoned for

calling attention to a few of its needs. Suppose some day, as many experts think probable, the Caribbean Sea should become the base of a great naval warfare. Florida undoubtedly would become a center of American activities. Her inland waterways, so far as they are fit, would be serviceable for supply and munition ships, and for small vessels of the navy. We can not count too much on these waterways now, for they have not been improved as they should have been. But what layman ever knew, or knows now, that the Coast and Geodetic Survey has 172,000 square miles of hydrographic surveying ahead of it before all sides of Florida are covered.

Our needs by way of protection against reefs and shoals around the Florida coast are far more extensive than they are in the Alaskan waters, and yet in Alaska but eight per cent. of the navigable waters have been surveyed to the satisfaction of the bureau.

The dangers of Cape Hatteras are known to every American, and the currents that abound on that treacherous coast demand the frequent inspection and oversight of the chart-makers. Just above Hatteras, along the North Carolina coast, the shore line is constantly changing, as is well known. Inlets close and open according to the whims of nature. It is an interesting historical fact that no living man is now able to locate the inlet through which passed the Sir Walter Raleigh expedition, which made the first English settlement on Roanoke Island in 1584. That the vessels of Amadis and Barlow entered Croatan Sound is well established, but the channel through which they came has long since disappeared.

The closing of inlets as far north as New York has not been of infrequent occurrence in the course of the last century, nor has the accretion or recession of land where the waves and storms have played upon it.

Near Chincoteague Inlet, Virginia, is a comparatively new harbor, known as the Assateague Anchorage. It owes its existence to a natural change in the coast line at the south end of Assateague Island, which has converted an exposed bight into a well-protected and much frequented harbor. This harbor is preferred by local shipping to some of the artificial harbors of refuge along the coast. It has an added importance because it is the only harbor between the entrances to the Chesapeake and Delaware bays, but it must be examined frequently in order that the shifting sands may be so charted as not to deceive the mariner.

Advancing along the coast to the New Jersey and Delaware shores, where shipping increases, it is observed that at the present time the Coast and Geodetic Survey stands in need of funds to survey and resurvey about 13,000 square miles off shore. There are shoals constantly forming on these shores which should be examined and charted in the interests of navigation. This is an area which is presumed to have passed the pioneer stage, but it evinces that same disposition to conform to the forces of nature that prevail in less frequented waters.

More remarkable than this, however, is the situation with respect to the waters approaching the great metropolis of New York. The Rivers and Harbors bill, now pending in the House of Representatives, carries an appropriation of $700,000 to extend and deepen the channel from the sea to the Brooklyn Navy Yard, a very important work that should have been completed long ago. The reason for this appropriation is that there are obstructions in the channel, possibly of rock foundation, which make navigation perilous for the dreadnaughts of the navy. When vessels of 12 feet draft were sailing into New York harbor it made no difference about this channel, but the increase in the size and draft of vessels has made a difference, and the lead and the drag must be invoked again.

There are rocks in the East River, as every one knows. Some of them are of the pinnacle type, and strange as it may seem have only recently been located. As late as 1915 the wire drag was used by the Coast and Geodetic Survey in the East River, locating certain dangerous shoals which are a menace to navigation, and which in the event of war would seriously handicap our battleships. If commercial New York, exposed as it is to the guns of a hostile fleet, is just beginning to make discoveries of new formations and obstructions in its waterways, it is high time that the people elsewhere along our coast lines should wake up to the importance of increasing and developing the Coast and Geodetic service.

I have not time to further discuss the work along the Atlantic coast except to say that the Maine waters abound in rocks and shoals. The wire drag service is badly needed there, as it is all along the New England coast. The report of a recent survey in the vicinity of the Rockland Naval Trial Course discovered no less than four shoals, on any one of which a battleship might have been seriously damaged. It is noteworthy also that in a survey of the approaches to Narragansett Bay, one of our most beautiful sheets of water, evidences of hidden formations were discovered. As

late as 1914 the wire drag party found no less than 50 shoals at the entrance to Buzzard Bay, from which vessels now pick their way into the newly constructed Cape Cod Canal.

The United States Corps of Engineers and its Relation to the United States Coast and Geodetic Survey: BRIGADIER GENERAL W. M. BLACK.

The association in work of the corps of engineers and the United States Coast and Geodetic Survey began with the organization of the Coast and Geodetic Survey.

The Corps of Engineers was organized as a separate body in 1802 and of it the U. S. Military Academy formed a part. The first superintendent of the Coast and Geodetic Survey, Ferdinand R. Hassler, was appointed from the corps of instructors of the academy, having served there as acting professor of mathematics from 1807 until 1810.

When the necessity for the better mapping of our coasts was impressed upon President Jefferson he selected Hassler to take charge, though it was not until 1816 that the work of the survey was actually begun. About a year later the work was discontinued, though the survey of the coasts was carried on thereafter by officers of the engineers and of the Navy until the bureau resumed its operations under Hassler in 1832.

Among the engineer officers on duty on survey work prior to 1832 was John J. Abert, who as major and lieutenant colonel, was engaged in many surveys of the coast from 1816 to 1827.

For several years beginning in 1818 the international boundary surveys required under the Treaty of Ghent were carried on along the northern boundaries of New York, Vermont, New Hampshire and Maine. Second Lieutenant Delafield, Captain Partridge and Professor Ellicott of the corps of engineers and Professor Hassler of the Coast Survey were engaged in the work.

When in 1843 it was deemed necessary to reorganize the Coast Survey the corps of engineers again lent its aid. Alexander Dallas Bache, a graduate of the Military Academy of 1825, and during his period of service in the army an officer of the corps of engineers, was appointed superintendent and remained as the head of the survey until his death in 1867.

In announcing his death the Secretary of the Treasury paid tribute to the value of his services in maintaining the high scientific character of the survey.

From 1843 through a period of many years, officers of both the Army and Navy served by detail with the Coast Survey Bureau.

The accurate method of observing latitude with the zenith telescope was the invention of Captain Andrew Talcott of the corps of engineers.

This record shows how directly the corps of engineers has been interested in the work of the Coast and Geodetic Survey.

During the past half century the two services have had few opportunities to associate in the same work, but the association of the two organizations does not end with this. Their work is mutually helpful.

When a harbor is to be improved the first recourse of the army engineer is to the charts of the Coast and Geodetic Survey, by means of which the changes which have occurred are studied and on these studies plans for improvement are afterwards formulated.

The triangulation points established by the Coast and Geodetic Survey are used when available as a basis for the work of the engineers.

Free interchange of information is made between the two organizations and the work of one supplements that of the other.

In a recent examination by the United States engineers of East River, New York, it became necessary to study the tides and tidal currents to determine the probable effect of certain proposed works. A careful study made in former years by Professor Henry Mitchell, of the Coast and Geodetic Survey, furnished much of the information required and checked closely with later observations by the engineers.

In considering plans for the improvement by the United States engineers of the Hudson River, a study of the tides and currents is of the utmost importance. Scientific research of this kind falls within the duties of both the corps of engineers and the Coast and Geodetic Survey.

To the unthinking it might appear that once the coasts had been charted the need of further surveys would cease. Such is not the case. The sea is both a builder and destroyer of shores and her labors are unceasing. Maps require constant and periodic revision.

In yet another way the work of the Coast and Geodetic Survey is useful to and is utilized by the corps of engineers and that is in the preparation of projects for national defense. For this purpose the charts of the Coast and Geodetic Survey are at once available.

The work of the Coast and Geodetic Survey and

that of the United States engineers touch at many points, but their respective spheres of duty are well defined and separate.

The great work done by the Coast and Geodetic Survey in its hundred years of existence and the traditions of faithful labor well performed will always be an inspiration for further effort.

The Lighthouse Service and its Relation to the United States Coast and Geodetic Survey: George R. Putnam.

All progressive maritime countries have recognized their obligation to survey their coasts and to light and mark them. When a country builds a lighthouse or publishes a chart of its coast, it aids the whole family of maritime nations, and such works show an international public spirit.

At the very beginning of our national government an act was passed, approved August 7, 1789, providing for maintaining the lighthouses. There were then but eight lighthouses in operation within the United States. From that small beginning has grown the present Lighthouse Service of this country, the most extensive lighthouse system under a single organization in the world. It maintains 14,544 aids to navigation; it employs 5,792 persons and uses 113 vessels in its work.

Maintaining lights, fog signals, buoys and beacons to guide vessels has required, in order to reach the highest effectiveness, the utilization of available apparatus and the development of new apparatus of a high order. There has been a continuous and a steady advance from the time of the first lighthouse in this country.

An accurate and thorough hydrographic survey of the coast is a necessary preliminary to the intelligent location of lighthouses and buoys and beacons; in fact, without an accurate chart it is always possible that a buoy or beacon may be stationed so as to lead a vessel directly on to some hidden and unknown danger.

The lighthouse work and the coast survey work have an important object in common; the purpose of both is to protect mariners and keep them out of danger, to give the shipmaster all possible help to steer a safe course. One gives him the map showing where the water is safe for his vessel, the other gives him the light, fog-horn and buoy to guide him over this course.

These services cooperate in many ways. The Coast Survey has made special surveys needed in connection with selecting the location for lighthouses, and has determined accurately their locations. The Lighthouse Service promptly marks new dangers located in the course of surveys, such as the wire drag work, and changes the position of buoys and other aids as is shown to be necessary by revised hydrography; it aids the Coast Survey with any information obtained by its vessels. A great amount of work is required in locating the aids correctly on the charts, and in keeping this information correct, and in this work there must be close cooperation between the services. On a single chart, that of New York harbor, there are shown 299 aids to navigation.

As both nature and the works of man are constantly changing the coast line, channels and harbors, and as the course and needs of commerce also are ever varying, it is evident that both the charts and the beacons for the aid of mariners must ever be corrected and modified; therefore the cooperation in these two important works must always be continued as in the past.

Hydrography and Charts, with Special Reference to the Work of the United States Coast and Geodetic Survey: George Washington Littlehales.

A century ago, the states and the people, through their senators and representatives in Congress, authorized the President of the United States "to cause a survey to be taken of the coasts of the United States in which shall be designated the islands and shoals, with the roads or places of anchorage, within twenty leagues of any part of the shores of the United States; and also the respective courses and distances between the principal capes or headlands, together with such other matter as he may deem proper for completing an accurate chart of every part of the coasts within the extent aforesaid."

Congress has shown the strength of intention underlying this enactment by making continuous annual appropriations through the one hundred intervening years and by authorizing as an aid to the prosecution of so important a public task large drafts from the army in earlier years and yet larger ones from the navy as long as they could be spared from the exacting needs of the battle fleet.

How was this justifiable, and how justifiable was it? The results served the life of the nation. No cargo is ever exported or brought home without invoking the protection of this survey; no ship ever enters or leaves our ports without receiving its aid.

In proceeding oceanward from the borders of the continent, along which the triangulation or

mensurational framework of the Coast Survey has been conducted and the topography delineated, the land dips gradually under the sea. It is the province of marine hydrography, by means of measurements of the depth of sea located in position with reference to the triangulation on shore, to discover and to chart the features of this submerged bordering land, thereby indicating the hidden dangers to be avoided by mariners and the channels where safety is to be sought in the guidance of shipping. The mission of the hydrographer has thus been that of a pathfinder to lead the way to our ports and harbors, not only at home, but also in the distant countries over which the jurisdiction of the United States extends; to tell the seafarer of the favoring tide, and by how much his compass declines from the true meridian; and to warn him where his safety is beset.

It must be with no small degree of pride that men should trace their professional lineage to a calling which has prepaid the premium of a policy of insurance upon the seaborne commerce of the United States and made the coast of the United States its best known geographical feature—a calling reaching so far back into the history of our country, so enriched with the heroisms of the sea and with the names of illustrious defenders of the nation, and so unexcelled for the aggregate of its influences in promoting the security of shipping and safeguarding the lives of seamen.

The Contribution of the United States Coast and Geodetic Survey to Geodesy: WILLIAM HENRY BURGER.

To be printed in SCIENCE.

The Civil War Record of the United States Coast and Geodetic Survey, and what the Survey is Doing towards Preparedness: REAR-ADMIRAL RICHARD WAINWRIGHT.

My acquaintance with the U. S. Coast and Geodetic Survey for over sixty years is my warrant for attempting to give the record of the field force of the survey during the Civil War. During my boyhood days I have listened to many talks about the deeds of the field force of the survey and have met many of the assistants who served in the army and navy during the Civil War. Their names would sound familiarly to the old cave-dwellers of this city. They were early volunteers of their services to the country, and their assistance was eagerly sought by generals in the field and admirals afloat. The officers of the survey were in frequent consultation with officers of the army and the navy in regard to operations along the coast, and in nearly all naval and military movements they aided by making reconnaissances and soundings, placing buoys and piloting in interior waters. The field force of the Coast Survey gave valuable military service to their country during the Civil War and afterward they returned to their regular duties, without any of the rewards of rank or pay or pension, for themselves or their families, so freely distributed at this time for military services; but they had the satisfaction that is the reward of all earnest workers of knowing that:

"Duty done,
Is Honor won."

Prior to the Civil War, and again some time after its close, naval officers were detailed to duty with the survey. They had the opportunity of learning to command and to exercise their own initiative. They had to learn to conquer difficulties and to make things do, for in no other government service is more required and smaller means provided for its accomplishment than in the Coast Survey. I am glad to see that the present superintendent is gradually forcing the Coast and Geodetic Survey from its dignified scientific obscurity into the light of the public eye. Congress will not appropriate liberally unless the public is interested.

The constant work of keeping our numerous harbors and channels correctly charted, with the aids to navigation located and the tides computed, is necessary for the commerce of peace, as well as in preparation for war; and there are points where a close survey is of value to the navy, although of little use to commerce.

In time of war the field force of the Coast Survey will be needed as it was during the Civil War. The army and navy are both very short of officers and there is little likelihood of its being otherwise for many years. A trained topographer would always be of value on the staff of a general. In modern war, with long-range guns, the general must visualize his work by close reference to the map and a topographer from the Coast Survey would find little training necessary to keep the new features and movements of the troops plotted ready for the commanding general.

In the navy a skilled hydrographer would prove a most valuable addition to the staff of an admiral. His power of quickly locating his position on a chart would be of assistance in bombardments, blockading, mining and counter-mining.

On the practical side the work of the survey has been well done and with economy. The Coast Survey charts stand at the head of all others for accuracy, execution and general usefulness. The

field force of the Coast Survey has always given loyal service to the country. If war should come they and their distinguished superintendent will be prompt to offer their services. They will be again ready. May they then find the nation more grateful than did those who were detailed from the survey during the Civil War.

The International Work of the United States Coast and Geodetic Survey: DR. OTTO HILGARD TITTMANN.

Speaking of the international work of the Coast and Geodetic Survey done in direct cooperation with other countries, Dr. Tittmann said that it may justly give satisfaction to the members of the survey that the results of its work are nearly all international in their scope.

The hydrographic and tidal surveys are obviously for the benefit of all mankind because they safeguard the commercial intercourse of nations. Its geodetic work contributes to the knowledge of the earth's dimensions and constitution. The world's knowledge of terrestrial magnetism would be incomplete without the record of the observation of magnetic phenomena as they occur in the vast territory inhabited by us and so with those relating to the tides. Thus in the prosecution of its tasks, the survey adds to our knowledge of the planet which we inhabit and thereby furthers the ultimate aim of all civilization, the intellectual development of mankind.

He then referred to Senator Sumner's speech delivered immediately after the acquisition of Alaska in which Sumner spoke of the north and south boundary of the territory just acquired as extending to the frozen ocean or the "North Pole if you please." Mr. Tittmann evidently believes that the Senator intended to lay the foundation for a claim to any land which might lie between Alaska and the North Pole. He pointed out that Admiral Peary visited the North Pole end of the line, and that during the famous journey he was formally attached to the Coast and Geodetic Survey for the purpose of observing Arctic tides.

After briefly reviewing the delimitation of the Alaska boundary, extending over a length of about 1,800 miles, by the survey, Dr. Tittmann described the part taken by the survey in the delimitation and remonumenting of our northern and also of the Mexican boundary, undertakings which he considered the most striking of the survey's international accomplishments.

He then spoke of the relation of the Coast Survey to the International Geodetic Association and its supervision of two small astronomical observatories for observing the variations of latitude, maintained in this country by the association. He also described the survey's share in the scientific work leading to the establishment of the International Bureau of Weights and Measures, pointing out that the directorship of this important bureau was offered to the American delegate, Mr. Hilgard, of the Coast and Geodetic Survey, but was declined by him.

International scientific expeditions made by the survey, including transit of Venus expeditions, and those for observing solar eclipses, were rapidly passed in review by the speaker, who, in concluding, expressed the hope that the next centennial celebration of the Coast and Geodetic Survey might afford as satisfactory a retrospect as the present.

Oceanic Tides with Special Reference to the Work of the United States Coast and Geodetic Survey: DR. CHARLES LANE POOR.

The mathematical theory of the tides begins by assuming a solid earth surrounded by a shallow, frictionless ocean. In such an ocean the attraction of the moon would cause waves to travel around the earth from east to west. For many years the complete mathematical solution of this simple problem taxed the ability of the ablest scientists, and when finally solved the solution did not materially advance the theories and explanations of the actual tides in the oceans as they exist on the earth.

To pass from this ideal world to actuality; from a simple all-pervading ocean of uniform depth, to oceans separated by continents, and varying in depth, defies the skill of the mathematician. Yet Newton, Laplace and a succession of brilliant mathematicians have all tried to do this; to pass from the simple to the complex. They consider the tides as a world phenomenon—as an ideally simple wave, modified, broken up, and delayed by the continental barriers; by the varying depths of the oceans. Sir George Darwin considers the great earth tides as formed in the broad, deep waters of the southern Pacific. From here the tidal wave spreads east and west, around Cape Horn and past Cape of Good Hope, and sweeps through the Atlantic at a rate depending solely upon the depth of the water.

This simple world idea of the tides was evolved and elaborated from observations of the tides of Europe. In the days of Laplace there was little knowledge of the tides in other parts of the world, and it was naturally thought that the European tides were fairly representative. The dy-

namical, or world wave theory, fitted and explained the simple tides, and thus became the basis of all tidal work and theories. Later the tides in the Pacific and Indian oceans were studied and were found to differ greatly from those of Europe, in fact, the tides of the North Atlantic are exceptional in their simplicity. Yet as each new complication was found, it was explained away, as a modification of the general grand wave, due to some local condition. The theory that the tides are a world phenomenon has the support of the world's greatest mathematicians and all the prestige their names can lend.

Certain investigation of the Coast and Geodetic Survey would indicate that this theory may not be the correct explanation of the oceanic tides. During the century of its existence this body of skillful observers and able investigators has collected and discussed an enormous amount of tidal data in both the Atlantic and the Pacific oceans. As these observations were collected and brought together, discrepancies were found; the tides of one port could not be fitted into and made to harmonize with the tides of another place. A few such discrepancies could be explained as modifications of the general tidal wave, but as observations were increased in number, discrepancies multiplied, and to fit all conditions, the general tidal wave would have to writhe and squirm, and change its form and character from place to place until it lost all semblance of a single uniform progressive wave. Gradually there has been evolved the feeling that the tides are not a world phenomenon, but are strictly local in character and in being; that the tides of the Atlantic Ocean are due to the oscillations in the waters of the Atlantic, independent of what has or may happen in the waters of the Pacific.

This idea of the tides as purely local phenomena, as opposed to the theory of a grand earth-wide wave, has been elaborated and developed by the Coast and Geodetic Survey into a thoroughly consistent theory. And this explanation of the tides stands out as the great scientific contribution of the Coast and Geodetic Survey to the theories of oceanic tides.

The Contribution of the United States Coast and Geodetic Survey to Physical Geography: DR. DOUGLAS WILSON JOHNSON.

Every division of physical geography is indebted to the U. S. Coast and Geodetic Survey for the invaluable contributions which it has made during the past hundred years of its existence.

Considering the general earth relations, we owe to the services of this organization much of our knowledge concerning the size and form of the globe. Among the Coast and Geodetic Survey's contributions along this line are its longitude determinations, international cooperative work in the determination of the variation of latitude, and the gravity and azimuth observations made in connection with extensive triangulation work. Terrestrial magnetism has received a special study along this line, and has added largely to our stock of information on this important phenomenon of the earth.

The physical hydrography of the ocean has been enriched by the detailed study of the form and composition of the bottom through the regular hydrographic operations of the survey and special oceanographic cruises which they have made. Our knowledge of the Gulf Stream and other currents of the ocean and its tributaries comes largely from the researches of the survey. Its work along tidal lines and regarding tidal currents has been truly monumental, and among its many important contributions along this line may be mentioned the exposition of the equilibrium theory of tides, and its development.

In the study of land forms, the detailed charts of coastal features revised by frequent resurveys gives a complete record of the changes in coastal topography, and by throwing considerable light on the laws of wave and current action have proven to be of incalculable value.

Even the physical geography of the atmosphere is indebted to the survey, for Ferrel's meteorological researches and other studies of the winds and related phenomena are among the important contributions of the survey along those lines.

At the banquet, on April 6, in addition to the address of the president of the United States, printed above, the following addresses were made:

The Minister of Switzerland said in part:

It may surprise some of you that the only foreigner who has the privilege to say a few words on this festive occasion is the Swiss minister. Needless to state that there is no foundation whatsoever for the facetious suggestion that profound political reasons governed the choice of the representative of the only country which has no coasts, no harbors and no navy, to assist in this Jubilee Celebration of the United States Coast Survey.

I owe my presence here to the circumstance which is alike honorable and agreeable to me, that the first superintendent of the Coast Survey, which now has grown so great and celebrated, was the Swiss engineer Ferdinand Rudolph Hassler.

At all times in the history of the United States some of my countrymen may be found, who assisted in the development of this country and who have made a place for themselves in the hearts of grateful Americans.

The activities of Professor Hassler, as founder of two of your great national enterprises, that is, of the Coast Survey and the Bureau of Standards, took place in the first half of the nineteenth century. A retrospect shows us, that during those fifty years my countryman had as contemporaries several distinguished Swiss, who emigrated to this country at about the same time. First among them, it gives me particular pleasure to mention Hassler's friend, Albert Gallatin, of Geneva.

Actuated by the same spirit as Lafayette, Gallatin at the age of eighteen crossed the ocean in order to fight for American independence. Later on he achieved the highest honors open to a Swiss in this country. He was not only the first foreign-born Senator of the United States, but for twelve years he served with acknowledged ability and success as Secretary of the Treasury under Jefferson and Madison. He went to England with John Quincy Adams as a peace commissioner and remained abroad until 1823 as Minister to Paris. After his return he declined the offer of the Democratic party to become a candidate for the Vice-presidency, because he wished to devote all his time to his scientific studies of finance, history and ethnology.

Not less well known to you, gentlemen, is the name of the Swiss naturalist, Louis Jean Rudolph Agassiz, of Motier, who during the twenty-seven years of his incumbency made famous the chair of zoology at Harvard. His son, Alexander Agassiz, who was born at Neuchatel in 1833, and who labored in the same field of research at Harvard as his father, was at one time an aid in the Coast Survey, with which he remained closely associated, as shown in his book "Three Cruises of the *Blake*." A very special reason for mentioning his name is that he was so highly esteemed by President Cleveland that the latter offered him the superintendency of the survey, but Agassiz preferred to continue his favorite researches.

The Secretary of the Navy, the Hon. Josephus Daniels, spoke of the cooperation between the Coast and Geodetic Survey and the navy and called particular attention to the fact that for a number of years naval officers were detailed for duty in the survey, where they had charge of the vessels engaged upon the hydrographic work. When the Spanish war began the naval officers returned to the regular naval duties on the fleets. Since that time all of the work of the Coast and Geodetic Survey has been done by civilians.

The Secretary of Commerce, the Hon. William C. Redfield, said in part:

The record of service that we close to-night is one of which any group of men may well be proud. The fine traditions of this service that survive in your hearts I know are dear to you. I know a little of what they have meant to you of personal sacrifice and of struggle under adverse conditions. I know what you have done in the lonely places of the world, unseen and unwatched, untold, with none to advertise. I want it known that we here know and appreciate and honor the men who carry the burden and heat of the day.

The work of surveying and engineering is not spectacular. It is not comfortable to climb a mountain peak with a pack of instruments upon your back. There is nothing that gets readily glorified in being a victim to mosquitoes in Alaska.

There are fine traditions in this survey and there are curious ones. I think it is not generally known that the artist Whistler was a draftsman in the Coast Survey. He is said by his fellow draftsman, who was a grandson of Francis Scott Key, the author of the "Star Spangled Banner," to have made more sketches than he did drawings.

I want to speak to you very briefly of the present and the future of the Coast Survey; what it is, what it has with which to work, what its task is, what it hopes to do.

The work is splendid in its sweep, from the Sulu Sea just north of Borneo to the cold waters of Alaska in the Pacific, and from the tropical waters around Florida to the Canadian coast in the Atlantic, and on all the continental area of the United States between, and all along the backward limits of Alaska.

Dr. T. C. Mendenhall, former superintendent of the Coast and Geodetic Survey, took as his theme the salient features of the careers of the various superintendents of the survey, starting with Hassler. He sketched the development and progress of the survey during its one hundred years of existence and expressed the hope that its work during the next century might compare in character with that of the first.

FRATERNITAS MEDICORUM; A REPORT AND A DISCUSSION

IN the issue of SCIENCE for August 6, 1915, an "Appeal to the Men and Women Engaged in Medical Practise and the Advancement of Medical Sciences" was published, asking them to join the organization of the Medical Brotherhood for the Furtherance of International Morality. It was signed by about 150 members of high standing in the profession of this country, many of whom enjoy an international reputation. Soon after its publication, we began sending out the appeal and an enrollment card to members of the medical profession. We wish now to give an account of the results thus far attained, and to discuss the nature of this venture and its merits.

Report.—To this date about 14,000 American physicians have enrolled as members of the Medical Brotherhood, the greatest part of whom are either members of medical societies of good standing or of societies which cultivate medical sciences. The appeal was also sent to some of the leading members of the profession of other neutral countries. Here again we obtained very encouraging results. We received, and continue to receive, requests from members of the medical profession of these countries to be enrolled as members of the Brotherhood of our country. Among our correspondents are such well-known men as Theodor Kocher, Einthoven, Thalma, Rovsing, Thunberg, Von Monakow, Zwaardemaker, de-Quervain, Jacquet, Marsden and others of similar high standing. The appeal was published in some of the medical and scientific journals of these countries, and we have the encouraging information that organizations similar to ours were started there. Quite recently the Nederlandsche Vereeniging voor Heelkunde (Holland) requested to be enrolled as a member of the Medical Brotherhood of this country. *We did not approach members of the profession in any of the belligerent countries;* nevertheless, we received requests to be enrolled from medical men in Finland (Russia) who probably read the appeal in Swedish medical journals.

The 14,000 members of the medical profession of this country who have enrolled as members of the Brotherhood represent about 15 per cent. of the number of physicians to whom the appeal was sent. We have, therefore, good reasons to consider henceforth the Fraternitas Medicorum as an established organization.

Analysis of Objections.—While it is idle to speculate as to the real attitude of those who did not respond to the appeal, certain instructive facts, capable of shedding light upon this question, may, nevertheless, be learned from an analysis of part of the correspondence we have had. We shall not include in the discussion the numerous letters in which the writers unreservedly and enthusiastically approve our movement. But we have to mention that among the enrolled members are some who originally looked upon the enterprise with misgivings. We shall mention further the instructive fact that a number of physicians asked for enrollment cards months after the appeal was sent to them, stating frankly that they threw away the appeal without even having read it, because they were bothered with too many war and peace circulars.

However, we received about 27 letters, the contents of which were unmistakably adverse to our movement. Nine of these communications were anonymous; they contained offensive remarks, assuming that the Medical Brotherhood was a part of an organized German propaganda, that the expenses were met by the German Kaiser.

Among those who signed the adverse letters are several from men who are of high standing in the profession and are personally known to us. Several of our correspondents, some of whom were during the present war for short periods in France, stated that there is not a neutral fiber in them.

Two correspondents objected to the idea that physicians have a higher claim to international morality than other people. Several of our correspondents said that they either could not see the object of the movement or, as one expressed it, he could not see where "the uplift comes in"; or, on the contrary, that the aim of the Brotherhood is too Utopian for them. Finally, several writers approved the idea in general, but thought that the organi-

zation of a Medical Brotherhood should be postponed until after the war.

The objections to the organization of the Medical Brotherhood, as far as could be ascertained from this small number of adverse manifestations, may be summarized as follows: (1) That it is a part of a German propaganda, or, at least (2) a veiled pro-German movement; that (3) it is meant to be a neutral body which, therefore, ought not to be supported because the paramount duty of American physicians ought to be to assist the Allies; that (4) physicians have no higher claim than other people to international morality; that (5) there is no object (no uplift) in this organization; that (6), on the contrary, the object is too Utopian and finally, (7) that the movement is premature.

Financial Resources.—Small as the number of our critics is, their adverse points of view merit public discussion. In so doing we shall deal in the first place with the most objectionable interpretation given to the aims of the Medical Brotherhood, namely, that it is a part of a pro-Teutonic propaganda and that it is financially supported by the German government. In the appeal, as well as in a letter published in the *Journal of the American Medical Association* (Vol. 65, p. 971), it was expressly stated that the Brotherhood is neither a pro-Teutonic nor a pro-Allies movement. Such assurances probably do not reach the type of men who are capable of writing anonymous letters. But we owe it to the medical profession at large to make the following statement regarding the financial resources of the Medical Brotherhood, which is as follows: Private contributions, to the amount of $630.00 were made, in smaller and larger sums, by some of the enrolled members. The main financial support comes, however, from the Carnegie Endowment for International Peace. The executive committee of this body granted us a liberal fund for the purpose of developing our organization. The executive committee is made up of such men as President Butler, President Pritchett, Elihu Root and others of similar high standing. It is quite safe to say that no individual with normal judgment could think for a moment that these foremost American citizens would consent to support a pro-Teutonic organization. But ought such a question have been raised at all by any fair-minded member of the profession in the face of the standing of the members of the committee which signed the appeal? Would, for instance, the surgeon generals of the Army, of the Navy, and of the Public Health Service have consented to be honorary presidents; if the Medical Brotherhood had any ulterior, pro-Teutonic or other un-American, tendencies?

General Discussion.—As to the other criticisms, they can be best met, we believe, by discussing the fundamental considerations underlying this movement. The term "brotherhood," it is true, recalls to mind a state in which all men shall treat one another like brothers—like good brothers. This is an ideal which may never be attained. The specter of the unattainable drives practical men away from such ideals. But it should be remembered that the ideal is of great educational value, if utilized merely to indicate the *direction* which our practical activities ought to take. However, the Medical Brotherhood directs its appeal only to the medical fraternity and does not intend to deal with unattainable objects. The medical profession has a training which is scientific in character and method, and which has, in modern times, among its precepts the following maxims: (1) That the development of a new view must be started on the basis of an assured fact and not from mere desire or by the impulse of an untamed phantasy. (2) That one need not be afraid to assume, or to work for, something which has not received the approval of that great authority, the practically wise man. (3) That one should not work for the demonstration of the correctness of the new assumption, or for the realization of the new aim, in the manner of the practical man, that is, by violent activities and in the expectation of attaining completely the desired end in a month or a year (perhaps to lose it in a shorter time), but, on the contrary, must work patiently, trying to attain the end, or even only small parts of it, by

steps which may appear to be very small but which offer the greatest chance for permanency. (4) That one is not to be discouraged by some failures. And, finally (5) that one is to care more for progress in the right direction, than for attainment of the goal.

Now the development of our organization was started on the basis of the following indisputable facts. The ethical relations between separate nations are far behind the state of morals governing the relations of individuals of the same nation. International morality progresses at best in waves, positive and negative, making perhaps three steps forward and two and sometimes four or five steps backward. However, during the normal state of the world's affairs, ethical men of all countries are ready to be guided by the two great moral principles: patriotism and humanity. The present world-wide catastrophe demonstrated, however, that even the most idealistic citizen is often incapable, and, in fact, is usually not in a position, to serve both ethical principles at the same time, while his country, right or wrong, is at war with another country. Physicians, however, are in an exceptional position; they are permitted and even required to observe both ethical demands even during war. In war the physician's services to his country are as necessary, as great, as that of the warrior, but he is in the fortunate position of being able to treat his compatriot and his country's foe alike. That standard of morality is upheld not only by the medical profession itself, but is practically demanded by the regulations agreed upon by the various international conventions, regulations which have been rarely broken even in the present most brutal war. Even in the present state of frightful confusion of judgment, practically no sane individual exists who would not consider this standard of morality desirable to obtain in all domains of human endeavor—if it were attainable. These are safe facts. Now the Medical Brotherhood was organized primarily to bring these instructive facts to the consciousness of the members of the medical profession, to tell them of their ethically privileged status. This message is not sent to non-medical men; neither do we mean to say to the non-medical man: we physicians are holier than thou. We wish only to convey to physicians the message that their profession permits them to remain at all times simultaneously patriotic and humane, and that they should train their character properly so that they could be fit to exercise this high privilege. The nearest and simplest end to be gained from such information is the consciousness of a sense of higher duties which comes from the knowledge of one's higher moral dignity.

There is no doubt that the medical profession is a noble calling. Do medical men represent a noble class? They ought to. There are two good reasons for such an expectation. "A medical man whose ethical standard is not above that of the average man is morally below him." His activities are of a most serious nature; they concern life; and, furthermore, they can not, as in other callings, be controlled by anybody or anything else but the physician's own conscience; that conscience therefore must be of a higher type. Then the physician has constantly to deal with suffering, that of the patient and of those to whom the patient is dear; sympathy, therefore, ought to be an integral part of the make-up of the desirable physician. It is true that the medical calling is at the same time the physician's business by which he makes his livelihood; it is therefore often afflicted with many of the moral shortcomings which frequently go with money-making occupations. The Medical Brotherhood, however, does not deal and does not have to deal with this side of the physician's life. It deals with the physician in his relation to his country, when he acts and has to act as a patriot; or when other countries are at war with one another, when the physician of neutral countries has to act as a humanitarian. Here every physician can afford to exercise his noble profession in a noble spirit. It is that for which the Medical Brotherhood appeals to all physicians of our country. That alone seems to us to be an object worth while working for.

The fact that within only about nine months

and without agitation and publicity about 14,000 members of the medical profession of the United States alone should have joined the Medical Brotherhood shows that we struck the right chord. This group of medical men and women, the vast majority of whom surely have more or less idealism, represents about 10 per cent. of the medical profession of this country. Moreover, there can be no doubt that the appeal issued by the committee exerted a morally favorable influence upon many members of the profession who did not formally join the Medical Brotherhood; and there is great probability that a good many will join it, when the war approaches its end.

In this connection we may call attention to the most encouraging fact that the medical journals of our country act in a most exemplary manner with relation to the war. None of the journals, at least none known to us, has indulged in offensive discussions of the various belligerent nations or made disparaging comments on the behavior of the medical members of these nations. The subject of the present war has been handled by the medical journals with rare good sense and tact. In a general way, the same may be claimed for the utterance of the members of the medical profession when made in lay gatherings or publications, although here the unavoidable small fraction of exceptions has not been lacking. The Medical Brotherhood has had occasion to remonstrate in two instances: in one with complete and in the other with partial success.

From the point of view of the scientific investigator, who is not afraid of Utopian ideals which may give him the direction for his work, but who works for his goal by small and practicable steps, we may claim for the movement of the Medical Brotherhood that it has a definite object, "an uplift," that it is not Utopian in its direction, that it was undertaken at the right time—when the medical mind was in a state of fermentation—*in statu nascenti*, and, best of all, that the movement has already attained a gratifying success: it has aroused the moral, humane spirit in a great many members of the profession in this country as well as in other neutral countries.

We have no quarrel with those of our colleagues who do not wish to join the Brotherhood, because, as they say, they can not be neutral in this war. No matter with which party one sides, and what his wishes may be, we do not question the moral nature of his motives. But we wish to make the following remarks: First, the Medical Brotherhood does not aim for mere neutrality. Neutrality is neither impartiality nor humanity. A neutral occupies, with reference to war, the same moral level as the belligerents, with the mere difference that he is not in it, or not yet in it. The Medical Brotherhood wishes to occupy a position above this level. War represents a very backward place in the development of human ethics. The various belligerent nations are simply products of the same moral phase, the same development period. The medical profession is fortunate to be able to occupy an advanced ethical position. Its members should be aware of it and should adhere to it. Secondly, the Medical Brotherhood is, from practical considerations, concerned only with the medical part of its members. As private individuals the members are at liberty to sympathize chiefly or exclusively with one side or the other of the warring parties. What we expect of members of the Medical Brotherhood is that they should commit no public act which is not in harmony with the advanced moral standing of the medical profession. One who does not feel that he can bind himself to this simple obligation, or one who does not believe, or does not want to assume, that the medical profession occupies an advanced moral position, should, of course, not join the Medical Brotherhood. This organization must consist of medical men and women who believe in the advanced ethical position of the medical profession and are willing to live up to this belief. It is as certain as day that only good and no harm can come from such a belief.

We shall not risk presentation of a list of problems which we may be called upon to try to solve now or later; "each bridge will be

crossed when we get to it." One thing we may state definitely: we do not intend to meddle with problems which deal with the terminating of the present war. The exertion of our energies will be limited to that which is attainable to us. On the other hand, we contemplate dealing definitely with this one problem: at the termination of the war, or even at the mere sight of this termination, an attempt should be made to unite the medical men of all the neutral countries for the purpose of arranging an early international meeting of the medical profession, to which meeting some members of the profession of the belligerent countries, who are or may then be in harmony with our ideals may be invited. We shall thus perhaps be in a position to accelerate an early *rapprochment* and fraternal reconciliation of the members of the medical profession of all the civilized nations. Here again we shall attempt to do our duty as we see it, without being too sanguine as to an early and complete success.

Hippocratic Oath.—A few of our sympathizing correspondents wished to know whether the aims of the Medical Brotherhood are not already covered by the Hippocratic oath. No; that oath covers only the relations of the physician to the individual as his private patient or pupil. As we all know, the influence of this oath leaves plenty of room for the ethical activities of the American Medical Association, the newly created College of Surgeons, etc. The Medical Brotherhood does not intend to deal with any part of this phase of medical affairs; it has in view exclusively the relations of the physician to his country as a patriot and to other countries as a humanitarian.

Patriotism and Medical Preparedness.—We have stated that medical men are in a position to be patriots and humanitarians at the same time. We have so far dealt exclusively with the international side of the Brotherhood. In fact, in the appeal it was expressly stated "For the Furtherance of International Morality." However, it would not be out of place to add a few remarks regarding patriotism and the relation of the physician to it. The present war, while presenting a frightful picture of the bloody struggle between the nations, has revealed, on the other hand, a most remarkable ethical side of the relations of the individual to the state in each and every one of the belligerent countries. The readiness of the individual to be helpful to, and sacrifice himself for, the state stands out as a shining light in the midst of the extreme darkness of the war. But here we wish to speak especially of the relations of our own physicians to our own country. Preparedness is a subject which at present agitates profoundly the minds of all of our citizens. It is none of our concern here to discuss this subject from the general point of view as citizens. As physicians, however, there can not be the slightest doubt that it is the duty of every member of the profession, who is in a position to do so, to offer his assistance to the medical department of the military organization of our country. We do not know when the country will be called upon to defend itself. It may come suddenly, like a bolt from the skies, which are surely not clear at the present time. Physicians who are not devoid of a sense of duty, should, therefore, prepare themselves with the necessary knowledge and skill, and should in large numbers inform the military medical department of their willingness to serve in case of need. The hygienist, bacteriologist and internist, etc., can be of just as much service as the surgeon in the incidents of war. The medical man who marches with the scouts ahead of the army to select camps, to test the drinking water, etc., is as important as those who work behind the lines. And the medical man whose daily work brings him in contact with infectious and contagious diseases is trained in courage as high as the veteran of many battles; bacteria are as deadly as bullets, and in his daily work the physician, like the man in the firing line, never knows when they may strike him.

On the other hand, the practitioner knows now quite well what importance is to be attached to sympathetic psychical treatment of patients who are in need of it. A training to preserve humaneness in the midst of passion and hatred ought to be a part of medical pre-

paredness. After furious battles the poor injured prisoner of war needs often this mode of treatment as much as the surgical one.

The Medical Brotherhood of this country wishes to gather into its union those members of the medical profession who have a vein of idealism in them and who are willing to serve their country as patriots and humanitarians. It appeals further to the inspired ones to spread this gospel, wherever they find opportunity, with impressiveness combined with patience and tolerance.

S. J. Meltzer,
President of the Medical Brotherhood

GRANTS FOR SCIENTIFIC RESEARCH

During the past year, the sub-committee on research funds of the Committee of One Hundred of the American Association for the Advancement of Science has endeavored to secure information regarding research funds and particularly such as are available without substantial limitations as to the residence or institutional relations of the grantee.

The following list of endowments of the latter class, while doubtless incomplete, is believed to comprehend the more important with the exception of those devoted to medical research. From most of them grants of moderate sums for research may be made to suitable applicants. The list is arranged alphabetically according to location.

Unless otherwise stated the figures given refer to the principal of the endowment. The amounts are to be considered as approximate only.

For information regarding the conditions upon which grants may be made from any particular fund, application should be addressed to the officer indicated in the list.

The present article constitutes a portion of a report made at the Columbus meeting of the American Association. Other portions will be published later.

American Academy of Arts and Sciences, Boston, Mass.

Rumford Fund. $66,300. For Rumford Premium and investigations in light and heat carried on in America. Charles R. Cross, Chairman, 28 Newbury St., Boston, Mass.

Cyrus M. Warren Fund. $12,500. For chemical research. Henry P. Talbot, Chairman, 28 Newbury St., Boston, Mass.

Elizabeth Thompson Science Fund, Boston, Mass. $26,000. "For the advancement and prosecution of scientific research in its broadest sense" without limitation as to country. Walter B. Cannon, Secretary, Harvard Medical School, Boston, Mass.

Harvard College Observatory, Cambridge, Mass. Advancement of Astronomical Science Funds; 1901, 1902. $40,000. For aiding work of astronomers in any part of the world. Edward C. Pickering, Director, Harvard College Observatory, Cambridge, Mass.

Davenport Academy of Sciences, Davenport, Iowa. Mary L. D. Putnam Fund. $23,000. A certain portion applicable to research. Edward K. Putnam, Acting Director, Davenport, Iowa.

Ohio Academy of Sciences, Delaware, Ohio. Annual gift. $250. Applied to research. Edward L. Rice, Secretary, Delaware, Ohio.

Engineering Foundation Board, New York City, N. Y. Ambrose Swasey Fund. $200,000. Regulations regarding use not yet formulated. F. R. Hutton, Secretary, 29 W. 39th St., New York, N. Y.

Sarah Berliner Fellowship for Women, New York City, N. Y. $1,000 annually. For study and research in physics, chemistry and biology. Mrs. Christine Ladd Franklin, Chairman, 527 W. 110th St., New York, N. Y.

New York Academy of Sciences, New York City, N. Y.

John Strong Newberry Fund. $1,000.

Audubon Fund. $2,500.

Esther Hermann Fund. $10,000.

For investigation in natural sciences. Michael Idvorsky Pupin, President, Columbia University, New York, N. Y.

California Academy of Sciences, San Francisco, Calif. Endowments yielding upwards of $65,000 annually, used in considerable part for research. Barton W. Evermann, Director, San Francisco, Calif.

American Association for the Advancement of Science, Washington, D. C.

General Research Fund. About $25,000. For investigation in any department of science. L. O. Howard, Secretary, Smithsonian Institution, Washington, D. C.

Colburn Fund. About $75,000. For "original research in the physical or psychic demonstrable sciences." Regulations regarding use

not yet formulated. L. O. Howard, Secretary, Smithsonian Institution, Washington, D. C.

National Academy of Sciences, Washington, D. C.

Bache Fund. $56,000. For research in physical and natural science. Edwin B. Frost, Chairman, Yerkes Observatory, Williams Bay, Wis.

Watson Fund. $25,000. For Watson Medal and astronomical research. Edward C. Pickering, Chairman, Harvard College Observatory, Cambridge, Mass.

Henry Draper Fund. $10,000. For Draper Medal and researches in astronomical physics. George E. Hale, Chairman, Mt. Wilson Solar Observatory, Pasadena, Calif.

J. Lawrence Smith Fund. $10,000. For J. Lawrence Smith Medal and the investigation of meteoric bodies. Edward W. Morley, Chairman, West Hartford, Conn.

Benjamin Apthorp Gould Fund. $20,000. For researches in astronomy. Forest R. Moulton, Chairman, University of Chicago, Chicago, Ill.

Wolcott Gibbs Fund. $5,500. For chemical research. Charles L. Jackson, Chairman. Harvard University, Cambridge, Mass.

Comstock Fund. $11,300. For researches in electricity, magnetism and radiant energy. Edward L. Nichols, Chairman, Cornell University, Ithaca, N. Y.

Murray Fund. $6,000. For Agassiz Medal and contributions to oceanography. Arnold Hague, Chairman, National Academy of Sciences, Washington, D. C.

Marsh Fund. $9,400. For research in natural science. Arthur L. Day, Secretary, National Academy of Sciences, Washington, D. C.

Carnegie Institution, Washington, D. C. Endowment Fund. $22,000,000. "To encourage in the broadest and most liberal manner, investigation, research and discovery, and the application of knowledge to the improvement of mankind." Robert S. Woodward, President, Washington, D. C.

Smithsonian Institution, Washington, D. C. Hodgkins Fund. $250,000. For investigations concerning atmospheric air. Charles D. Walcott, Secretary, Washington, D. C.

Washington Academy of Sciences, Washington, D. C. Fund of $5,000. Available in part for research. George K. Burgess, Secretary, Washington, D. C.

Archeological Institute of America, Washington, D. C. Fund of $25,000. For excavations in Mediterranean lands. Mitchell Carroll, Secretary, Washington, D. C.

National Geographic Society, Washington, D. C. Research Fund. $35,000. For exploration and geographical research. Gilbert A. Grosvenor, Secretary, Washington, D. C.

CHARLES R. CROSS,
Chairman

THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A MEETING of the members of the American Association for the Advancement of Science, residing in or near New York, was held at the American Museum of Natural History on Friday, May 5, at 5 P.M., to discuss plans for the New York meeting of the association in December. About fifty members were in attendance. Mr. Henry Fairfield Osborn was elected chairman and Mr. Henry E. Crampton secretary of the meeting.

The chairman called attention to the special interest of the forthcoming gathering as it involved an unusual number of scientific societies which were affiliated with the association. Called upon by the chairman to outline the present plans for the Convocation Week meetings, Mr. J. McK. Cattell stated that the committee on policy of the council had placed arrangements in the hands of an executive committee consisting of Messrs. Charles Baskerville, Nathaniel L. Britton, J. McKeen Cattell, Simon Flexner, Henry Fairfield Osborn, Michael I. Pupin, John J. Stevenson and Edmund B. Wilson. Certain details as yet unsettled were then presented for discussion by those in attendance, who represented the 1,350 local members of the association.

The cooperation of various institutions and scientific societies was tendered by Henry Fairfield Osborn, George F. Huntington, Alexander Smith, N. L. Britton, R. A. Wetzel, Charles L. Bristol, President Marsh, C. Stuart Gager and Professor Margaret B. Wilson. After discussion, it was *voted* that the executive committee be requested to consider the advisability of the appointment by the local

scientific societies and institutions of representative cooperating committees, and, if possible, to arrange for the establishment of such committees.

It was further *voted* that the executive committee invite each local member to contribute the sum of $5 toward the general expenses of the Convocation Week meetings. It was *voted* to recommend to the executive committee that Columbia University be the general headquarters of the meetings. The action of the executive committee appointing Mr. J. McKeen Cattell as local secretary was confirmed by vote. Finally it was *voted* to recommend to the executive committee that a reception committee be formed, to consist of both men and women, for the arrangement of such social activities as may be deemed desirable.

The meeting adjourned at 6.15 P.M.

Henry E. Crampton,
Acting Secretary

SCIENTIFIC NOTES AND NEWS

The Royal Society has elected as foreign members: Prince Boris Galitzin, head of the Russian Meteorological Service; Dr. C. L. A. Laveran, of Paris, discoverer of the malarial parasite; Dr. Johan Hjort, director of Norwegian Fisheries; Professor Jules Bordet, the bacteriologist of the University of Brussels, and Professor H. Kamerlingh-Onnes, professor of physics at Leyden.

Although obituary notices of Ivan P. Pawlow, the distinguished Russian physiologist, have been printed in the *Journal* of the American Medical Association, *The Lancet, Das Umschau* and other journals, it was noted in Science that there may have been confusion with E. W. Pawlow, court surgeon, who died in St. Petersburg on February 11. The Russian Embassy confirms the death of E. W. Pawlow, but can give no information concerning Ivan P. Pawlow. Dr. Francis G. Benedict now writes us that a letter from Madam Pawlow to Mrs. Benedict, received on May 4, and postmarked March 28, states that her husband had not been quite well through the winter. There is thus good reason to believe that the report of his death is incorrect.

Professor W. S. Thayer, of the Johns Hopkins University, gave the presidential address before the Congress of American Physicians at Washington, on May 9, his subject being "Teaching and Practise." We hope to have the privilege of printing this address in the next issue of Science.

The trustees of the Johns Hopkins University announce that the ninth course of lectures on the Herter Foundation will be given by Dr. Theobald Smith, director of the department of animal pathology, the Rockefeller Institute for Medical Research, on May 11, 12 and 15. The subject is "The Relation of Infectious and Immunizing Processes to the General Phenomenon of Parasitism."

Sir Almroth Wright, London, has been elected a foreign associate of the Paris Académie de Médecine.

Dr. Giuseppe Sergi, professor of anthropology in the University of Rome, has completed his seventy-fifth year. In honor of the occasion the Roman Anthropological Society has decided to publish a volume of memoirs.

At the annual meeting of the Iron and Steel Institute, on May 4, the Bessemer gold medal for 1916 was presented to Mr. F. W. Harbord.

The Howard Taylor Ricketts prize for research work done by students in the departments of pathology and bacteriology of the University of Chicago, which is awarded each year on May 3, the anniversary of Dr. Ricketts's death from typhus fever, has this year been awarded to Oscar J. Elsesser.

The Walker prize of the Royal College of Surgeons (£100) has been awarded to Mr. W. S. Handley, of the Middlesex Hospital Cancer Research Laboratory, for his work on cancer.

At the annual meeting of the Marine Biological Association of the United Kingdom in the rooms of the Royal Society on April 12, Sir E. Ray Lankester was reelected president, and Dr. A. E. Shipley, chairman of council.

Captain E. F. Dickins, former head of the New York office of the United States Coast and Geodetic Survey, has been placed in charge of the San Francisco office as the successor of Captain Ferdinand Westdahl.

A LEAVE of absence for the second half of the academic year 1916–17 has been granted by Harvard University to Professor Theodore W. Richards, director of the Wolcott Gibbs Memorial Laboratory.

ASSISTANT PROFESSOR NORMAN MACLEOD HARRIS, of the department of hygiene and bacteriology at the University of Chicago, has been granted a year's leave of absence, beginning with the autumn quarter, in order that he may give his professional services to the Canadian contingent in the European war.

DR. FRANK M. CHAPMAN, curator of ornithology at the American Museum of Natural History, proposes to make explorations in the Andes during the present summer. The expedition is part of a plan to secure several new habitat groups of birds in South America, including the condor and the rhea. Mr. George K. Cherrie and Mr. L. E. Miller will accompany Dr. Chapman.

A SERIES of five lectures has recently been given on the Hitchcock Foundation at the University of California by Professor Thomas Hunt Morgan, professor of experimental zoology in Columbia University. The topics of the lectures were as follows:

April 12. "A Revelation of the Evidence on which the Theory of Evolution was based."

April 14. "The Bearing of Mendel's Discovery on the Origin of Hereditary Characters shown by Wild Species."

April 17. "The Factorial Hypothesis of Heredity and the Composition of the Germ Plasm."

April 19. "Sex Factors and the Mechanism of Sex Determination."

April 21. "Is Selection a Creative Process?"

AT a meeting of the California Chapter of Sigma Xi on April 19, Professor F. P. Gay, of the department of pathology, University of California, as the retiring president, presented an address upon "Specialization and Research in Science." Officers for the ensuing academic year were elected as follows: *President,* C. L. Cory, dean of the College of Mechanics; *Vice-president,* G. N. Lewis, professor of physical chemistry; *Recording Secretary,* T. B. Burnett, assistant professor of physiology; *Corresponding Secretary,* Edmund O'Neil, professor of inorganic chemistry; *Treasurer,* A. C. Alvarez, assistant professor of civil engineering.

DURING the exercises in connection with the Shakespeare Tercentenary Commemoration at the University of Texas, April 22–26, Professor William E. Ritter, director of Scripps Institution for Biological Research at La Jolla, California, delivered an address commemorative of Harvey's demonstration of the circulation of the blood in 1616. The subject of the address was "'Know Thyself'—Interpreted by Socrates, Shakespeare, Harvey and Men of To-day." On the evening of the twenty-seventh, at the annual banquet of the Texas Chapter of Sigma Xi, Dr. Ritter read a paper entitled, "Are we obliged to assume that Spontaneous Generation ever occurred?

ON March 21, Dr. Shepherd Ivory Franz, of Washington, D.C., addressed the students of Swarthmore College on "The Psychology of Delusions" and on March 28, Professor Warner Brown, of the University of California, on "The Psychology of Advertising."

DR. JOHN W. HARSHBERGER, professor of botany in the University of Pennsylvania, conducted an illustrated science conference on "Field Research in Plant Geography and Ecology" on Saturday evening, April 22, at the Brooklyn Institute.

PROFESSOR E. S. MOORE, of the Pennsylvania State College, lectured before the Mining and Geological Society of Lehigh University on April 13, and before the students of the department of geology at Cornell University on April 26 on "Some of the Mining Fields of Australia and India."

AT the annual meeting of the Alabama Society of Mental Hygiene held in Birmingham, on April 8, Dr. Thomas W. Salmon, New York, medical director of the National Committee on Mental Hygiene, delivered an address to the society on "Feeblemindedness."

MR. J. S. DILLER, of the Geological Survey, and Dr. Arthur L. Day, of the Carnegie Geophysical Laboratory, addressed the Geological Society of Washington, on April 12 on "Lassen Peak, California."

Nature states that the applications received for admission to Miss E. A. Browne's lecture on "Our Tropical Industries," at the Imperial Institute, London, on Wednesdays, have been so numerous that no further tickets for Wednesdays can be issued. It has, however, been decided to repeat the lectures on Thursdays in April, May and June, at 3 o'clock, commencing on April 27, and tickets for Thursdays may now be obtained at the Imperial Institute.

UNDER the auspices of the Geographical Society of Philadelphia, the annual Heilprin Memorial Lecture was given in the auditorium of the University of Pennsylvania Museum on Wednesday evening, April 19, by Professor Lawrence Martin, of the University of Wisconsin. His subject was: "The Gorge of the Upper Mississippi as a Rival of the Rhine Gorge."

THE Le Conte Memorial Fellowship endowed by the alumni of the University of California in memory of John and Joseph Le Conte has been awarded for 1916–17 to John Hezekiah Levy, for graduate work at Columbia University in international law.

"TOLAND AMPHITHEATER" has been selected as the name of the amphitheater in the new University of California Hospital in San Francisco, in honor of Dr. Hugo H. Toland, the founder and long a member of the faculty of Toland College of Medicine, which eventually grew into the present University of California Medical School.

LUCIEN IRA BLAKE, A.B. (Amherst, '77), Ph.D. (Berlin, '84), professor of physics and electrical engineering at the University of Kansas from 1887 to 1905 and later chief engineer of the Submarine Signal Co., died in Boston, on May 4, aged sixty-one years.

SIR COLIN CAMPBELL SCOTT-MONCRIEFF, distinguished as a soldier, as an engineer, and as an administrator, died on April 6, at the age of seventy-nine years.

MR. J. H. COLLINS, an authority on geology and mining in Cornwall, died on April 12, at the age of seventy-five years.

THE death of Octave Lignier, professor of botany at the University of Caen, celebrated for his contributions to paleobotany, occurred on March 19.

THE first number of *Physiological Abstracts* has been issued under the sponsorship of the Physiological Society of Great Britain and Ireland, with the cooperation of the American Physiological Society, and other American, British and continental scientific bodies.

THE first number of a bimonthly journal entitled *Revista de Matematicas* has appeared at Buenos Aires under the editorship of Manuel Guitarte.

THE *Journal* of the American Medical Association states that the Army Medical Museum possesses a valuable collection of medals relating to medicine which was started and fostered by the late Dr. John S. Billings, and it is highly desirable that this collection should be added to and completed, so far as possible. The assistance and advice of physicians who are collectors of medical medals is respectfully solicited. The museum appropriations will avail to purchase individual medals which are not in the collection, the purchase of private collections, or of individual items in them, will be carefully considered, and private donations of separate medals or groups of medals will be most welcome and will be duly credited to the donors, and the transmission of catalogue of medals for sale is requested.

THE contract between the Ohio State Board of Administration and the Otho Sprague Memorial Institute for the establishment of a laboratory at the Chicago State Hospital for research work in dementia praecox has been signed, and the opening of the laboratory now awaits only the selection of a director. The medical director of the Sprague Memorial Laboratory is Dr. H. Gideon Wells of the University of Chicago.

DR. W. A. MURRILL, assistant director of the New York Botanical Garden, writes that there has just come to his notice, through Mrs. Rufus Hatch, of Pelham Manor, New York, a very serious case of mushroom poisoning in which the poisonous specimens were taken from mushroom beds and were supposed to be a new edible variety. The common mush-

room had been cultivated successfully in these beds for two years. Five persons ate the supposed new variety and enjoyed its flavor but were almost immediately stricken with paralysis, their lives being saved only by the prompt action of their family physician. This indicates that it is very unwise to eat or sell any mushroom appearing in mushroom beds except the ordinary cultivated variety with white cap and pink gills. A description of this new poisonous mushroom has been prepared for immediate publication in *Mycologia*.

THE twenty-fifth session of the Marine Biological Laboratory of Stanford University at Pacific Grove, Cal., will begin on May 22, and continue six weeks. Courses will be offered in general zoology and embryology. Provision will also be made for students who are prepared to undertake advanced work in zoology. To investigators who are engaged in research, the use of the laboratory is offered free of charge. The laboratory will be under the general supervision of Associate Professor J. O. Snyder. Further information may be obtained from Mr. Snyder, or from the directors, Charles H. Gilbert, professor of zoology, or Oliver P. Jenkins, professor of physiology, Stanford University, Cal.

THE German Congress for Internal Medicine in Warsaw was planned for May 1 and 2. Last year a similar congress for surgery was held in Brussels. At this congress the diseases which are of particular importance at this time, especially typhoid, typhus, cholera, diarrhea, diseases of the heart and nephritis, will be discussed.

UNIVERSITY AND EDUCATIONAL NEWS

THE contest of the will of the late Amos E. Eno is now on trial in a New York court. If the will is sustained Columbia University will receive over $7,000,000.

HARVARD UNIVERSITY has received $10,699 from the estate of Miss Rebecca W. Brown, to be added to the fund created by her brother, Buckminster Brown, for the foundation of a professorship of orthopedic surgery.

PROFESSOR CHARLES H. RICHARDSON, of Syracuse University, has given to the department of mineralogy his private collection of minerals and rocks, which is valued at $5,000. The collection is being relabeled and placed on exhibition in new cases in the natural history building. The collection will bear the name of the donor.

NEW YORK UNIVERSITY will require two years of college preparation as a condition of entrance into the medical college beginning in 1918.

THE degree of bachelor of arts will hereafter be awarded to students of Columbia College, whether or not they have studied Latin, the degree of bachelor of science being abolished.

DR. DAVID STARR JORDAN, chancellor of Stanford University, has retired with the title of chancellor emeritus.

THE council of New York University has appointed Dr. Samuel A. Brown to be dean of the medical department of the university.

THE summer session of the University of California, which last year enrolled 5,388 students, for its session this year, from June 26 to August 5, will include among the visiting members of its faculty B. M. Allen, professor of zoology, University of Kansas; E. R. Clark, professor of anatomy in the University of Missouri; Moses Gomberg, professor of organic chemistry, University of Michigan; D. S. Hill, director of the Bureau of Educational Research, New Orleans, and E. J. Wilczynski, professor of mathematics, Chicago.

IN the department of natural science of the Michigan State Normal College at Ypsilanti, Dr. Bertram G. Smith has been promoted from assistant professor to associate professor of zoology.

DR. ERNEST G. MARTIN, of Harvard University, will succeed Professor Oliver P. Jenkins, as head of the physiological department of Stanford University.

DR. ROBERT M. OGDEN, professor of psychology in the University of Kansas, has been elected head of the department of education in Cornell University and will take up his work

there at the beginning of the next academic year. Dr. William S. Foster, now instructor in psychology in Cornell University, has been made assistant professor of education.

DISCUSSION AND CORRESPONDENCE

THE ORIGIN OF PACIFIC ISLAND FAUNAS

To the Editor of Science: In the current number of Science (April 14) I read with interest the abstract of a paper by Dr. Pilsbry on the land shells of the Pacific islands as a guide to former geographic conditions. The author rejects "the hypothesis that Pacific snails reached the islands by oversea drift" because it "leaves the absence of higher snails unexplained."

It is perhaps dangerous to criticize an argument from an abstract, but as this point has been cited in other cases where I know it involved a fallacy, I venture to suggest that Doctor Pilsbry may also have overlooked the fact that the older a given group is the longer time there has been for the chances of oversea dispersal, hence the greater the probability of its reaching the more remote islands. Obviously a group which has not become dominant until the later Tertiary has but a very small chance of having reached remote islands as compared with a group that was dominant during the Mesozoic or earlier. Certain features in the Mesozoic and early Tertiary climates would tend to increase greatly the chances of oversea transport, and a third explanation might be cited in the differences of habitat which would tend to facilitate the drift dispersal of some types more than others. That the higher types should be found in the larger islands and those nearer to the continental platforms is quite to be expected; and by the law of chances, where only a limited number of primary stocks of the more ancient groups have reached the more distant islands, one ought not to expect to find any of the groups of comparatively recent dominance.

With many if not most groups of land invertebrates, as with the land vertebrates, the evolution and dispersal of the modern dominant fauna took place during the Tertiary, and much of it I suspect rather late in the Tertiary. But, as also with vertebrates, the wide oceanic dispersal of the older or lower groups may be due more to their greater facilities for dispersal than to their greater antiquity.

W. D. Matthew

BELGIAN HARE, A MISLEADING MISNOMER

In a paper entitled "Anatomical Adaptations in the Thoracic Limbs of the California Pocket Gopher and Other Rodents,"[1] Charles Daniel Holliger has identified the so-called Belgian hare as *Lepus europaeus* (p. 449). At various places in the text and particularly in the last paragraph of the summary (p. 489) he comes to the conclusion that "domestication reduces specialization" and that "the typical cursorial modifications [of the Jack rabbit] have either disappeared or have been much reduced in the Belgian hare."

As a matter of fact the "Belgian hare" is a domestic variety of the European rabbit and the striking differences observed by Holliger are due to inherent generic differences, the Jack rabbit belonging to the genus *Lepus* and the European rabbit and with it the Belgian hare belonging to the rather conspicuously different genus *Oryctolagus*.[2] Or to put it the other way around, the striking differences observed by Holliger (see especially table p. 487) are part of those on which the genera *Lepus* and *Oryctolagus* are founded.

M. W. Lyon, Jr.
George Washington University

THE VAPOR PRESSURE OF SOLUTIONS

In Science of January 14 last Arthur Tabor Jones describes an apparatus for observing the change in the volume of solutions in the presence of the solvent owing to the difference in the vapor pressures. He could not determine the rate of change owing to the roughness of the bell jar. The following apparatus has

[1] *Univ. Calif. Publ.*, Vol. 13, pp. 447–497, March 7, 1916.

[2] See Lyon, *Smiths. Miscell. Coll.*, Vol. 45, pp. 323, 406, pl. 98, June 15, 1904; and Miller, Cat. Museum West. Europe Brit. Mus., p. 485, November 23, 1912.

been used by me and has proved very satisfactory.

In a foot-cylinder with a ground top is placed a smaller graduated cylinder containing the solution. The larger cylinder contains sufficient solvent to reach nearly to the top of the smaller one. The system is enclosed by a ground-glass vaselined plate covering the outer cylinder. Gradually the volume of the solution increases and the change in volume can be accurately followed and recorded.

In an experiment which lasted two months the total change in a nearly saturated salt solution was from 5.8 c.c. to 6.6 c.c., or nearly 14 per cent. This is to be repeated for verification, and other solutions of various solvents and solutes studied.

JAMES H. RANSOM

PURDUE UNIVERSITY,
March 25, 1916

SCIENTIFIC BOOKS

Engineering as a Career. A series of papers by eminent engineers, edited by F. H. NEWELL and C. E. DRAYER.

This book of 214 pages is made up of selections from the writings of different engineers so chosen as to embrace a broad field of practise. It is a mosaic presenting attractive fragments from the work of active leaders in steel-making, in manufacturing, in marine engineering, in railroad operation and maintenance, in municipal administration, in industrial management, in architecture, in mining and metallurgical work, and in other equally interesting and important lines of activity. The book opens with a general discussion of the engineer and his profession by Mr. Albert J. Himes. Mr. Worcester R. Warner speaks especially from the standpoint of the mechanical engineer, Mr. A. W. Johnston from that of the railway engineer, and Mr. Chester W. Larner from that of the hydraulic engineer. Altogether twenty-two selections are presented. They make an impressive picture drawn by men of experience, concerning the opportunities offered to and the attributes of character required by one who seeks a career as an engineer.

The book will interest parents, ambitious for the success of their growing sons, who are approaching the question as to whether their sons shall go to college, and if so, whether they shall seek to become engineers; it will interest multitudes of high-school boys, who are wavering between the call of business and that of the technical or professional school; and it will interest engineers who enjoy any well-considered formulated statement which seeks to set forth broad views of the engineer's problem and of the place which he must assume in society. But it is especially for the boy and for the parents of boys.

The editing has been a labor of love, the work having been done by Mr. C. E. Drayer, secretary and later president of the Cleveland Engineering Society, and by Professor F. H. Newell, head of the department of civil engineering of the University of Illinois, who for twenty-five years served the government in an engineering capacity, principally as chief engineer and later as director of the United States Reclamation Service which has been responsible for the building of great reservoirs and irrigation canals throughout the arid west.

W. F. M. Goss

UNIVERSITY OF ILLINOIS

The Rare Earths. By S. I. LEVY, B.A. (Cantab.), B.Sc. (Lond.), A.I.C., Late Hutchinson Research Student of St. John's College, Cambridge. Longmans, Green and Company. With illustrations. Pp. 359. Net, $3.00.

This is the first book published in English that attempts to give a fairly comprehensive account of the rare-earth group, and the magnitude of the task has resulted in a volume of considerable size.

An introduction written by Sir William Crookes, himself a master in this field of research, does much at the outset to give the book standing.

The work is divided into three parts: I. Occurrence of the Rare Earths; II. Chemistry of the Elements; III. Technology of the Elements. The author has included zirconium and titanium among the elements treated, because of their occurrence in rare-earth min-

erals. Just why columbium and tantalum do not find a place here for the same reason is not altogether clear; but of course a limit had to be set.

Part I. classifies the minerals as follows: (1) silicates; (2) titano-silicates and titanates; (3) tantalo-columbates; (4) oxides and carbonates; and (5) phosphates and halides. Such a classification of the one hundred and fifty or more rare-earth minerals, giving the percentages of the chief rare earths present, is useful and has already been adopted by other authors. A valuable addition to this list is the giving of the locality where the minerals are found.

Part II. discusses adequately and satisfactorily, on the whole, the chemistry of the elements. A fair amount of attention is given to the separation processes so many and complicated in this group. The spectroscopic methods, absorption, spark, arc and cathode luminescence, methods themselves of the highest value, are duly emphasized, and Urbain's recent application of magnetic susceptibility receives its proper consideration. It is of interest to note that the lanthanum test consisting of a blue color when iodine is brought into contact with the hydroxide find a place in the book, although no one of whom the reviewer knows has been successful in applying it.

Part III. is concerned mainly with an account of the development of the incandescent light industry. This is a most instructive history, and deserves all the space assigned to it, as it has given the main impetus to rare-earth investigation during the past thirty years.

A feature which commends the book is its international scope. American, English, French and German chemists will find their work fairly represented.

The book is an important contribution to inorganic chemistry, and should be in the library of every inorganic chemist for study or at least for reference.

Philip E. Browning

Relativity and the Electron Theory. By E. Cunningham. Longmans, Green and Company, London. Pp. vii + 96.

The author has a large work on this subject printed by the Cambridge University Press and now presents a short monograph, from which the more difficult mathematical work is omitted. The result is a book which may be read without serious effort, even by persons not specialists in the theory of relativity or in mathematical physics. The titles of the chapter are: I. Introductory; II. The Origin of the Principle; III. The Relativity of Space and Time; IV. The Relativity of the Electro-magnetic Vectors; V. Mechanics and the Principle of Relativity; VI. Minkowski's Four-Dimension Vectors; VII. The New Mechanics; VIII. Relativity and an Objective Æther. Throughout the work emphasis is laid upon the physical foundations of relativity and upon its physical consequences. Something is also said of the philosophical meaning of relativity.

The natural book with which to compare Cunningham's is Carmichael's Monograph, "The Theory of Relativity," published by John Wiley and Sons. The essential element of contrast is that Carmichael proceeds in the Euclidean fashion from definite assumptions or postulates to definite theorems; whereas Cunningham writes in the ordinary style of the physicist. The one lays greater stress on logical foundation, the other upon the physical connections of the theory. So different is the point of view that even though the results overlap to a large extent, any reader of one of the monographs would find much additional interest in reading the other. The change in the concepts of mass and time and space which is suggested by the theory of relativity is so perplexing to many persons that the reading of both these texts will be none too much to allay their anxieties. The mathematician should begin with Carmichael and the physicist with Cunningham.

Edwin Bidwell Wilson

SPECIAL ARTICLES

THE RELATION OF OSMOTIC PRESSURE AND IMBIBITION IN THE LIVING MUSCLE

1. A series of independent observations by Nasse, the writer, Overton, Meigs, Beutner,

v. Körösy, and probably others, have shown that the striped living muscle of a frog neither loses nor absorbs water when put into the solution of any sugar or neutral salt whose osmotic pressure is equal to that of a $m/8$ NaCl solution, provided the salt does not injure the membrane.[1] If the solution surrounding the muscle has a higher osmotic pressure the muscle will lose water, if it has a lower one the muscle will take up water. The normal, living muscle acts, therefore, as if it were surrounded by an ideal semipermeable membrane which allows water to pass through while it is impermeable for the neutral salts or sugars. The accuracy with which the muscle responds to slight changes in the osmotic pressure of the surrounding solution in the neighborhood of the isotonic point is so great that this response might be used to determine roughly the molecular weight of sugars or neutral salts. Since there is only one variable in which the isosmotic solutions of different sugars and salts of the same osmotic pressure agree, namely the number of molecules in the unit volume of the solution, we are forced to assume that the osmotic pressure is the driving force for the exchange of water between muscle and surrounding solution, provided that the surrounding solution does not destroy the semipermeability. This is not only true for the striped muscle, but also for the nerve (A. P. Mathews), for the excised kidney (Siebeck), for the red corpuscles (Hedin and others), for the sea-urchin egg (Loeb), and probably generally. The only exception known is the smooth muscle (Meigs).

2. In 1898 the writer[2] called attention to the rôle of acid formation in the muscle upon the absorption of water. He had found that if the muscle lies for a number of hours in an isotonic solution of NaCl the muscle begins to absorb small quantities of water (p. 462) and he ascribed this effect to the formation of acid (p. 464), probably lactic acid, in the muscle. He also interpreted the rapid absorption of water by an active muscle in an isotonic solution to an absorption of water due to an acid formation, and he pointed out that absorption of water due to acid formation might play a rôle in phenomena of growth (p. 466) as well as in certain phenomena of edema (p. 467 ff.). The main phenomena of edema discussed by the writer in his paper have since been shown by Moore to be due to circulatory disturbances.[3]

The question remains, how the formation of lactic (or any other) acid can increase the absorption of water in the muscle. The writer assumed that this was due to an increase in the osmotic pressure of the muscle as a consequence of the acid formation; and this idea is, as he believes, correct. The only point in which his views as expressed in 1898 may require a modification concerns the way in which the formation of lactic acid (or of acid in general) increases the osmotic pressure of the muscle. In 1898 he assumed that the hydrogen ion acted like a hydrolytic ferment and increased the number of molecules in solution in the muscle by splitting certain larger molecules into smaller ones. This is, of course, *a priori* possible, but not proven in this case. A second possibility is the increase of the osmotic pressure of certain colloids under the influence of acid as observed by R. Lillie, Moore and Roaf, and others. A third possibility is connected with the explanation of imbibition given by the work of Procter, Pauli, and very recently Katz. According to this work we may assume that through a chemical combination of the acid with a protein the latter forms definite hydrates with water, in which process a diminution of volume with heat production occurs. If acid is formed in the muscle the proteins of the latter combine with the acid and with water. The number of molecules of water which one molecule of acid-protein (or rather one protein-cation) can bind seems considerable. This water is taken not from the outside, but from the solution inside the muscle. As a consequence of this

[1] A fuller discussion of these experiments is found in SCIENCE, 1913, XXXVII., 427.

[2] Loeb, J., *Arch. f. d. ges. Physiol.*, 1898, LXXI., 457.

[3] Moore, A. R., *Am. Jour. Physiol.*, 1915, XXXVII., 220.

withdrawal of water the solution inside the muscle becomes more concentrated and assumes a higher osmotic pressure than that of a $m/8$ NaCl solution. Hence if such a muscle is surrounded by a $m/8$ NaCl solution the difference in osmotic pressure of the solution inside and outside the muscle must lead to a diffusion of water into the muscle.

The *direct* driving force for the exchange of water between muscle and surrounding solution is, therefore, again the osmotic pressure.

3. These ideas are so self-evident that their publication would seem superfluous were it not for the fact that Wolfgang Ostwald and other colloid chemists deny the existence of semipermeable membranes in the muscle on account of the fact that acid causes proteins to undergo imbibition. It seemed, therefore, of some importance to point out that the imbibition of the proteins of a muscle under the influence of acid formed inside contradicts neither the existence of a semipermeable membrane around the striped muscle nor the paramount rôle of osmotic pressure in the exchange of water between such a muscle and its surrounding solution.

Jacques Loeb

The Rockefeller Institute
for Medical Research,
New York

SOCIETIES AND ACADEMIES

THE KANSAS ACADEMY OF SCIENCE

The forty-eighth annual meeting was held in Memorial Hall at Topeka, Kansas, January 14 and 15, 1916. The following, among other papers, were read:

"Civilized Europe: a Chapter in Anthropology," by A. A. Graham.

"Botanical Notes," by L. C. Wooster.

"Some Experiments with *Bacillus coli communis*," by L. C. Wooster.

"Observations on Jupiter at Opposition in 1915," by Edison Pettit.

"A Universal Heliostat," by Edison Pettit.

"Additions to Kansas Coleoptra, to 1916," by W. Knaus.

"Some Life History Notes on *Phytonomus eximins*," by W. Knaus.

"Rare Coleoptra from the Sand Hill Region of Reno County," by W. Knaus.

"The Clan System of Wyandot Indians," by William E. Connelley.

"Echinacea and its Use," by J. M. McWharf.

Presidential Address—"American Highways," by J. A. G. Shirk.

"Properties of Kansas Clays," by Paul Teetor.

"Notes on the Comanchian of Kansas," by W. H. Twenhofel.

"Relative Toxicity of Aromatic Oils and Inorganic Compounds on Fungi," by L. J. Reiser.

"The Gorship Indians of Utah," by A. B. Reagan.

"Some Nutritional Characteristics of Corn," by J. T. Willard.

"The New Public Health," by J. C. Crumbine.

"A Study of Foods for Infants," by Leon A. Congdon.

"Stramonium," by L. D. Havenhill.

"The Chemical Products of Physical Fatigue and their Possible Relation to Mental Efficiency," by F. C. Dockeray.

"A Method for the Determination of Salicylic Acid in Aspirin," by G. N. Watson.

"Isolation of the Toxic Principles of Coffee and Determination of their Toxicity," by L. E. Sayre.

"Calcium Metabolism," by C. F. Nelson.

"Differentiation within the Acid-fast Group of Organisms," by N. F. Sherwood.

"Breeding Habits of some Annelids," by W. J. Baumgartner.

"Eugenic Studies in Kansas," by W. R. B. Robertson.

"Effect of Environment upon the Germ Cells," by B. M. Allen.

"Population Changes and Industrial Development," by P. F. Walker.

"Explosions in Kansas Coal Mines: Their Cause and Prevention," by A. C. Terrill.

"More about Kaw Lake," by J. E. Todd.

"Eolian Loess," by J. E. Todd.

"On the Occurrence of Starch in some Green Fruit Products used for Jelly-making," by E. H. S. Bailey and W. S. Long.

"The Chemical Characteristics of Ground Water," by F. W. Bruckmiller.

"Experimental Modifications in the Development of the Germ Glands of the Frog," by W. W. Swingle.

The officers elected were as follows: J. E. Todd, *President;* F. G. Agrelius and L. D. Havenhill, *Vice-presidents;* W. W. Swingle, *Secretary;* and Wm. A. Harshbarger, *Treasurer.*

SCIENCE

FRIDAY, MAY 19, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

TEACHING AND PRACTISE[1]

IT would be impossible to address this congress without a word of affectionate tribute to the memory of three great men who have presided over these meetings in years that have passed, figures, alas, that we shall not see again.

Fitz, the patient, discriminating student, the wise, inspiring teacher, whose keen eye and orderly mind shed light upon obscure corners of the art of medicine; Mitchell, the poet, the brilliant physiologist, the acute and sympathetic reader of men's minds, the great practitioner; Trudeau, the optimist who, in his long journey through the "valley of the shadow of death," led so great an army of sufferers to the land of light. 'Tis a heavy loss. But what a varied and lasting inspiration the lives of these men have left for us and for the world!

In the last several years, especially through the activities of the American Medical Association, the Carnegie Institution and the General Education Board, questions relating to medical education have been discussed very actively in America, and the changes and improvements in our methods of teaching and in the character and training of those who teach have been greater probably than in any other like period in the history of American medicine.

The relations between teaching and practise in hospital and in university have of late been the subject of especially vigorous controversy in this as in other countries. To one who for five and twenty years has

[1] Address of the president of the Congress of American Physicians and Surgeons delivered at Washington on May 9.

been engaged with more or less activity in the practise as well as in the teaching of medicine, who has been associated with two universities in which interesting experiments in medical education are now in progress, these discussions have been of absorbing interest.

With all the divergences of opinion and amid all the heat of discussion the goal aimed at is almost universally the same. It is our desire that the hospital, the school of medicine and the teaching staff shall be so organized that the ultimate service to humanity may be the largest; that we may gain greater knowledge of disease; that we may acquire more efficient means, public and private, of recognition, prevention and alleviation of the innumerable ills to which the human race and its inarticulate companions and servants are heir; that we may become more efficient in the care of our patients; that we may train better physicians. These are the main ends of the study of medicine. It has seemed to me well to devote this hour to a discussion of some of the phases of the relations between practise and teaching.

In the early days, the study of medicine in this country was begun in the office of the practising physician. By and by there developed schools of medicine in which the teachers were successful practitioners. The first of these schools were associated with hospitals, and although the body of teachers was not large, yet John Morgan in his famous address on medical schools, early pointed out the necessity that special branches of medicine should be taught by men who had given their greater attention to these branches in practise. The professors of medicine and of surgery who bore the brunt of the teaching and directed their departments were usually busy men much sought for by the public in their community; and the teaching in the old days consisted largely of didactic lectures, with but limited demonstrations. Only thirty years ago, at the time when I was a student of medicine, the duties of the professor of theory and practise consisted solely in the delivery of several didactic lectures a week; those of the professor of clinical medicine consisted in the giving of two demonstrative clinics and one clinical conference. An assistant professor held one recitation a week. An occasional ward visit was given in one or another of the large hospitals, but these opportunities were improved by but a small proportion of the students. Physical diagnosis was taught during the second year to a class of about ninety by three instructors in several hourly exercises a week in sections of 20–30. This constituted the work of the department of medicine.

The direction of such a department was properly confided to a distinguished practitioner, a man of wide experience; and its management involved demands upon his time no greater than were compatible with the suitable performance of his hospital and private duties.

In such a school of medicine the clinical instruction of a single medical department or unit could be, and often was, carried out in a variety of hospitals—those hospitals with which the professors of medicine had the good fortune to be connected. The only association between the university and the hospitals was, in many instances, an amicable agreement on the part of the latter to allow instruction in the out-patient departments, through public clinics in amphitheater and operating room, and to a certain limited extent in the wards. There were no university laboratories connected with the hospital. University laboratories existed at another center which might or might not be near, or at a considerable distance from the hospital. These laboratories depended in large part upon the hospital

for their material, but did not often, excepting through the good will of the clinician and pathologist, control the supply; and, excepting to a very limited extent, the laboratories at the school rendered no especial service to the hospital.

In such a school of medicine a hospital was an accessory, a very close and valuable accessory to be sure, but yet an accessory to the department of medicine. And in discussing matters of medical education the hospital and the medical department of the university might be considered separately.

To-day the hospital must be considered not as an accessory to the department of medicine, but as its vital center. One can scarcely conceive of a school of medicine wholly independent of its hospital. The laboratories for the study of the chemical and anatomical and physiological phenomena of disease can not well exist at a center removed from the hospital, or under the control of individuals other than those directly associated with the hospital management. On the other hand, the hospital in many instances has come to depend largely on the cooperation of the university in the performing of some of its most essential functions. Professors, assistants, undergraduate students all go to form a corps of hospital servants invaluable to the institution. In a word, the relations between hospital and school of medicine are so close and intimate to-day that a discussion of the organization of a medical or surgical clinic, or of a department of pathological anatomy, presupposes the assumption that hospital and university be under one management or in such close affiliation as to form a single working body. For the ends aimed at by both hospital and school of medicine are closely related. The main, specific purpose of the hospital is the care of the sick; that of the school is the training of physicians. The care of the sick can be carried out best through the employment of physicians of the highest order, and for these the hospital turns to the school. But to offer the student the best possible training the school must have opportunities for the study of disease and of pathological material, and for these opportunities it turns to the hospital. The delicacy and complication of modern methods of chemical and physical diagnosis demand laboratories and laboratory equipment which involve considerable and steadily increasing financial outlay; they call, moreover, for students of the best chemical and physical training to preside over these laboratories. This has brought it about that general hospitals which are not integral parts of a university must turn to universities for assistance, or spend, for the installation of independent laboratories and apparatus and for the employment of salaried heads of these departments, a sum of money which to many institutions is almost overwhelming. The university laboratories of bacteriology, serology, physiological chemistry and so forth where studies which are, in many instances, most practical, are to be made, should be in or adjoining a hospital. Thus the economy and mutual advantages of cooperation are clearly apparent. And more than this, in the true university hospital which is centrally situated, a community of interest is constantly drawing together the clinical and so-called scientific departments. This is particularly true of the departments of physiology, physiological chemistry and pharmacology—and to the great mutual advantage of hospital and of university.

To-day in the better equipped and organized institutions there is in ward and laboratory, in hospital and school a common effort to contribute to the advance of the science and art of medicine in its broadest sense. Both hospital and school are centers of original research. However cordial and

however free a cooperation there may be between the university and hospitals situated at a distance from the central plant, one must acknowledge the necessity to a modern medical school of one central hospital. And so it has come about that any discussion of the organization of a modern medical clinic presupposes that which, for purposes of illustration, may be called a "university hospital" as its center, and calls for a consideration of certain hospital arrangements as an integral part of the problem. Such a hospital should be organized upon a basis entirely different from that which used to prevail and still exists in many institutions. The medical clinic or the surgical clinic, if it is to do its full duty to the public, to the hospital and to the school should be a well-organized unit under the control of a single director and a corps of associates and assistants. And of this corps of associates and assistants, some at least, preferably a considerable number, should be salaried men, who are required to give a large part of their time to their hospital and university work. All of these men should be members of the teaching staff of the university. Only in a clinic organized on some such permanent plan can constructive research be carried out or systematic instruction given. The old-fashioned rotating service is incompatible with the ideals of a modern hospital or university.

According to the size of the institution one or more such clinics may exist, and there is no reason why in a large hospital there might not be two or more separate clinics, or why in a given university there might not be several more or less independent professorships of medicine with clinics at different hospitals, if the means were forthcoming to supply the necessary material for the full organization of such clinics.

But to return again to the organization and constitution of a single department of medicine as compared with that of thirty years ago. The changes in the method of teaching clinical medicine have been great. Demonstrative clinical lectures remain an important element of medical teaching. But the place of the didactic lecture has largely been taken by practical instruction before small groups at the bedside. This involves a considerable increase in the teaching staff and increases greatly the amount of time which the teacher must give to his work. Thirty years ago the professor of medicine may have been expected to give two or three hours a week to his classes. To-day he could hardly be expected to devote less than six or eight hours to personal teaching. The problems of the teaching of physical diagnosis in its restricted sense are not so different from those of thirty years ago; but to-day it is generally recognized that the university should offer the student far more individual practical training than he used to receive. In the old days, three men, let us say, were entrusted with the teaching of a class of ninety; to-day the work would be distributed among six or eight at least.

Thirty years ago there was no such thing as a clinical laboratory, and clinical microscopy and chemistry were not taught in the medical department. Indeed, there were no special medical laboratories. To-day a modern medical clinic must, in the first place, control a clinical laboratory presided over by men who are called upon to give a considerable portion of their time to the training of the student in a large variety of methods of examination of secreta, excreta and body fluids; and this laboratory should also be a center for scientific research. Thirty years ago, it was easy for one man to preside over the entire department of medicine and to conduct his practise as well. It is extremely difficult, if not impossible, for

a practitioner to preside over the clinical laboratory to-day, and at the same time to do justice to his responsibilities as a physician.

Chemistry as related to the practise of medicine thirty years ago played a relatively small part in the medical curriculum. It was mainly restricted to its application to the study of urine, and those studies were for the most part of a simple character. To-day the chemical problems involved in the studies of human metabolism and used in the art of diagnosis are numerous and complicated, and are steadily increasing. No well-equipped medical clinic can exist without a department of chemistry, which should be presided over by a man of training and experience, capable of conducting and directing research and of overlooking the necessary studies of a variety of problems which arise in the wards of the hospital, for, as has been pointed out, no school of medicine can fulfil its mission to-day without intimate association with an adequate hospital. It is not easily conceivable that the director of the chemical laboratory could find time for medical activities outside the clinic.

The older methods of physical examination, so called, although mastered only by practise and experience, were yet mechanically simple. To-day, however, for the exploration of the human body and its activities, there are employed physical procedures which involve the use of instruments of great delicacy and demand a highly specialized technique. And subdepartments of radiology and electrocardiography each with its laboratory and its director, are necessary constituents of the modern department of medicine.

The medical clinic should also have a special department of bacteriology and serology, another subdepartment the direction of which demands much of the time of an experienced student. Of these laboratories also the director should be one who is able to organize, conduct and stimulate research.

Again, there should be in association with every medical clinic a department of physical therapy for the study and application of mechanical, hydro- and electro-therapeutical methods; and especially for the teaching of massage and of general physical training. Such a department might, it is true, be under the combined control of affiliated medical and surgical clinics, but some of the responsibility for its organization and direction should lie with the chief of the medical service.

It has been said that the directors of these subdepartments could hardly be expected to give any essential part of their time to the practise of medicine. Are they therefore wholly to be removed from the care of the sick? Is the department of medicine to have under its control a number of subdepartments presided over by so-called "pure" bacteriologists, physiologists, physicists, chemists—men who are entirely removed from direct responsibility for the care of the sick? Far from it.

In the ideally arranged department of medicine, all of these men should have clinical duties and responsibilities—duties and responsibilities which, in a hospital, may be systematized. And in the properly organized department of medicine, although many of its members may in a sense be specialists, yet none will fail to acquire a wide general medical experience.

Let us now for a minute reconsider the problems which confront the director of a department of medicine to-day. The teacher of thirty years ago followed a relatively simple routine. The chief of a modern medical clinic finds himself the head of a complicated machine, involving the appointment of a large number of salaried assistants, the manipulation of a consider-

able budget, which alas! under present circumstances, rarely meets the demands of the situation, the coordination of a large staff of trained workers in clinical, chemical, physical, bacteriological, serological and physiological departments, and the organization of a system of group teaching to which he must himself devote a very considerable amount of his time. It is evident that the director of such a department should be a man who has had a rather broad training, who shall have had a basis of chemical instruction such as was impossible thirty years ago, and shall have spent a sufficient amount of time in work in each of the branches represented by the subdepartments of his clinic to enable him at least to comprehend the significance of the work which is there being done, and to carry out real supervision.

Time was when the teaching of medicine was, in great extent, a matter of authority. The student was led to accept precepts enounced *ex cathedra*. To-day the teaching of medicine is largely a matter of demonstration, of example, of practise. The student is inclined rather to distrust precept for which proof is not adduced; he is offered opportunities to study the symptoms of disease and its treatment by the bedside, and is instructed in methods by which he may control and confirm so far as may be, the assertions which he may read in the book or hear from the lips of the instructor. The method of authority has given way to the method of observation and inquiry.

Who should preside over such a clinic as this? Who is the ideal director of the modern medical department? Thirty years ago the professor of medicine was properly he who had obtained the greatest reputation as practitioner or consultant. This reputation was often not attained before the age of fifty, and was gained through the active practise of the art. Such a man, who with years, might or might not have attained financial ease, might suitably, in these days, have been called upon, at a nominal salary, to direct a department and to give the two or three hours a week which were the sum total of the time exacted by the teaching duties of the professor.

But to-day it would be extremely difficult, nay, it would be almost impossible, for a man with a considerable consulting practise to organize and direct a medical clinic, such as that which I have outlined, and, in addition, to do the amount of personal teaching which would be necessary. The practitioner, even if he be purely a consultant, is not master of his own time. He may limit his consultations to special hours, but he can not cut off the increasing calls which appeal to his sympathy and come at any moment. And even if he see ever so few patients, he can not control the complicating side-questions to which relations with any one ill human being are too apt to give rise.

With the consultant as with the practitioner *sensu stricto* the human influence is the most important element in his work. The preliminary conferences indispensable for the establishment of the necessary relations of sympathy between physician and patient, the interminable confidences of the nervous invalid, the unravelling of the tangled mental complexes of the psychoneurotic sufferer, the heart to heart talks, the breaking of sad news, the straightening out of the many complications which so commonly arise in connection with grave illness, the letters to physician and family, the interviews with friends and relatives —these, as the consultant well knows, are the duties that consume his time; but they are necessary and essential parts of his work. It is not the actual time that the physician spends in the study of his patient —that is often the smaller part of it. It is the accessory duties that render it impossi-

ble for such a man properly to combine active consulting practise with the responsibilities of the directorship of a large modern clinic.

To accept such a position would necessitate the abandonment of a large part of that physician's practise; this would mean the loss of the main source of his income, unless he were a man of independent means. If then the professor of medicine in a modern university is to be chosen from the ranks of those men who have acquired great experience through professional success, it will be necessary either that the university shall pay a very considerable salary, or that the professor shall be a man of independent means. Such a salary, unfortunately, if men of this class are to be obtained, would have to be quite beyond anything that is at present possible in most universities. The successful consultant is usually put to considerable expense for the maintenance of the machinery necessary for his work, and in many instances comes to maintain a sort of existence which involves large financial responsibilities. However much such a man might desire to avail himself of the fascinating opportunities offered by the directorship of a large medical clinic, it is too commonly the case that, by the time he has well entered upon his fifth decade he has already assumed responsibilities toward others which make it impossible for him rightly to abandon the sources of his income. But this, it seems to me, is not the essential feature of the situation. Is the physician who through years of practise has become the successful consultant, the man who is best fitted to direct a large department of medicine or surgery? By no means always. Indeed, in the majority of instances, it is another course of life which should best fit a man for a university professorship.

There has arisen gradually in this country a new class of consulting physician, the man who has deliberately planned his career from the outset, who has sought through long years of study in hospital and in laboratory, in association with large clinics, to gain in a concentrated fashion, as it were, that experience which may make his clinical opinion, both from a diagnostic and therapeutic standpoint, most valuable. Long-continued service in institutions in which proper opportunities for study and research are offered, is giving to the public to-day a number of men who, while thoroughly trained and practised in modern methods of diagnosis and treatment, have accumulated, at a relatively early age, a store of actual clinical experience such as is acquired in independent practise only after a much greater time and, in the majority of cases, with a loss of touch with some of the more recent advances in medical science. These men, the products of intelligent methods of hospital management and organization, are as a rule soon called on by their colleagues in more active practise for advice and assistance as general consultants. Men who have pursued such a career, which has inevitably involved at the outset a considerable financial sacrifice, are usually men of scholarly tastes who keep in touch with laboratories in which they may continue research and cooperate with their colleagues in practise in the study of the nature and treatment of diseases. It is from this class of men that the professorships of medicine are more and more likely to be filled. Such a man may well enter upon a professorship by the time, or even before, he is forty years of age.

This leads us directly to one of the questions which has been most actively discussed of recent years: Is a man who has obtained his clinical experience largely or purely in hospitals properly fittted to teach students the essentials of the practise of medicine?

A distinguished student of the problems of medical education has been quoted as saying essentially: "Diseases are the same in the rich and in the poor, in human beings and in animals. To the clinician the ward is his laboratory, and the study of disease in the patient in the ward is, in all essentials, the same as the study of disease in the animal in a laboratory. The only difference between the study of disease in hospital and outside is that in the hospital the patient may better be observed. It is a mistake to say that it is necessary for a professor of medicine to have had experience in private practise when the same experience may be obtained more intelligently and in a much more concentrated form in the hospital."

This conception which has, by some, been regarded as characteristic of the point of view of those who have favored the establishment of professorships of medicine on the so-called "full time" basis, has been looked upon as fallacious and dangerous by many of the opponents of certain modern tendencies in medical education.

"No man," they say, "is fit to teach students the art of the practise of medicine who has not himself passed through the experiences of the practitioner. Practise in a hospital ward is one thing; practise in the home of the patient, another. He who has been accustomed to rely on the trained nurse and on the many appliances and instruments of precision which a well-appointed hospital affords, can have little conception of the difficulties which he will encounter in private practise. He whose only experience has been with the trusting, unresisting patient in the general wards, will find himself at sea when treating the whimsical, critical, prejudiced, opinionated invalid in private life. He who has been accustomed largely to study serious diseases in the wards of the hospital will have small sympathy with, and little understanding of the trivial complaints of the supersensitive and nervous members of the more well-to-do classes. The conditions that he is called upon to treat are to be remedied in great part by minor regulations of habits and manner of life, of eating and drinking and smoking and exercise. His main duties consist in ministering to the minds of his patients—in kindly counsel and encouragement—in advice tending toward the alleviation of a thousand petty ills which he who knows that they will pass with time, does not even consider in himself—which the less sensitive patient in the ward barely notices. How can one who has never had this experience teach students the art of practise? Is it not folly to take away the teaching of medicine from the experienced practitioner and to give it to one who has had a training which might almost be called academic? Must we not regard this idea as the dream of the layman and of the laboratory student who, with all his scientific attainments, is yet wofully ignorant of the conditions of the doctor's life and of his duties?"

There is much truth in these objections. I should have no hesitation in agreeing that the medical experience suitable to qualify a physician as a consultant or a teacher of medicine can not well be obtained wholly in the free wards of a hospital. There is a great difference between the mental workings of the patient in the free ward and those of the average individual with whom one is thrown in private practise. The stolid indifference to outside influences shown by many patients in the general wards renders the study of disease in hospital not so very different, it is true, from the study of disease in the laboratory, but so soon as one becomes associated with patients of a higher mental order, problems in diagnosis and in treatment arise which are

much more difficult and complicated. It is, it seems to me, not easily possible for one who wishes to fit himself for practise as a consultant or for the teaching of medicine to gain that experience which he should have without a considerable association with individuals of more complicated mental constitution. Moreover, there are certain diseases which, strangely enough, are rarely seen in the free wards, yet are common in outside practise, diseases the recognition and management of which are of the utmost importance. I need refer only to angina pectoris. A man who is not familiar with the mental attitude of the people among whom he or his students are going to be thrown, who has not learned by experience successfully to navigate his bark through the mist of accessory problems which befog the antichambers of the sick room, is unable to give to the student much that will be of real value in the practise of medicine. But fortunately in many hospitals to-day, the great development of private wards offers abundant opportunity for the acquisition of just this experience. The man who desires to fit himself for a position as teacher of medicine or consultant should spend a considerable period of time in practise among the class of patients which is to be found in the large private departments of many of our hospitals. Such an experience gained in the hospital will afford him in concentrated manner just what he might obtain otherwise through a much longer period of time in private practise.

This is the general course of training which the aspirant to the professorship of medicine is likely in the future to follow. His elevation to the directorship of a large department of medicine or surgery may be directly from the clinic in which he has occupied a salaried position and to which he has given his entire energies, or it may come after some years of consulting practise during which he has preserved close relations with an active clinical department.

Recognizing the magnitude of the problems associated with the organization of a large medical clinic, it has been felt that such a department could best be presided over by men who were able to give their whole energies to the university in organization, in teaching, in the conduct and direction of research. And, notably at that institution with which I have been connected for more than twenty-five years, several of the clinical departments have been reorganized upon a university plan. Through the generosity of the General Education Board, the institution has been enabled to establish a staff of university professors and salaried assistants who take charge of these clinics for hospital and university. These men, freed from the calls of outside practise, are able to give their entire time to the service of the department in the care of patients, the promotion and conduct of research and in the teaching of medicine. And as is well known, the members of this staff have agreed to abstain from the practise of their profession for their own emolument.

The discussion associated with this experiment has been very active, centering largely upon the last mentioned circumstance—the withdrawal or abstention of the university professors and their assistants from private practise. Those who have objected to this procedure have regarded the plan as unwise and even unfair to the physician himself, to the hospital, to the students and to the public.

In the first place, with regard to the professor himself, it has been pointed out, and with justice, that there can be little relation between the salary which the university could or should pay to the professor of surgery or medicine and the gross income of the successful surgeon or consultant in

a large city. It has been asserted that the opportunities brought by a considerable income for wide association with the world at large are broadening to the character of the man and are indirectly of value to the institution with which he is connected; that furthermore it must be a very serious question to the physician himself whether he is justified in planning deliberately a manner of life which can never lead to wealth or real financial freedom, when there might be open to him an opportunity to give to his family and those dependent on him the advantages which come with a large income. Is he not, it is asked, giving up the "larger life" for the smaller, and will not the university in the end suffer by the loss of the wide domestic and international relations so often established by the professor who has the material resources to visit his distant colleagues in their clinics and to entertain them at his home? Will not the hospital, more directly, lose in the absence of those cordial relations which arise to-day from the association, as a consultant, between the chief of the medical clinic and the practising physician?

Will not the students suffer, it is asked, through their association only with men who have had a more or less academic training in a hospital, who are out of touch with the exigencies of actual medical practise? Will not practitioner and consultant suffer seriously in losing their control of the hospital material which is now to pass wholly into the hands of salaried men? And will not the public suffer? May it not indeed be regarded as an injustice to the public and to the practitioner that they should be denied the services of these men especially eminent in medicine or surgery, whose opinions presumably are of special value—these men who have been chosen to direct large clinics?

It can not be denied that these objections have a certain force.

The physician who, starting from modest beginnings, has acquired, by hard work, a large income can not underestimate the blessings and the opportunities that such a revenue brings to him and to those who depend upon him. But such incomes are rarely honestly gained without very hard, very confining work, and without real intellectual hardship to the practitioner if he be a man of scientific tastes or aspirations. To one who has the temperament and ideals of the student, the advantages of a university professorship can not fail to appeal very strongly. No man who covets a fortune should select a career of a university professor. He who enters upon such a life knows from the outset what his income is to be, and what the outlook for his family. He can not expect to be a rich man, and he must plan his life accordingly. But the compensations are great to one of scholarly tastes. The opportunities for study and research offered by the university clinics and laboratories, limited though they may be at certain times by the demands of teaching, the freedom from the uncertainties, the complications, the endless activities of the life of a busy practitioner or consultant, the hours for reflection, for rest, for recreation offered by the stated vacations—these, wholly apart from the privileges and responsibilities of the organization of a large department, are advantages so great that they will always attract men of the highest order.

"And the larger life?" Who can say what "the larger life" is in itself? The "larger life," alas, does not always go with wealth and that which surrounds it; and who shall say that the opportunities which come to the university professor of distinction and to those about him are more restricted than those which are open to the

practitioner and consultant? Certain of the luxuries of life the professor may be obliged to eschew, but there are other privileges which will be his that no money can buy.

It is true that the salary of the university professor has not, in general, advanced with the incomes of those about him, or with the general scale of living; and it is, I believe, folly to attempt to put the directorship of clinical departments on a university basis at salaries such as have been in the past offered to the professors in the strictly scientific departments. Nevertheless, no one can expect such salaries to be large as compared with the income of successful men in private practise. It should, moreover, be remembered that with the successful consultant, for instance, nearly one half of his gross income is often absorbed by the legitimate expenses of his practise. The burden of these expenses is lifted from the shoulders of the university professor whose fixed income represents a revenue of nearly twice that size with the consultant.

But the salaries of university professors, whether in clinical or scientific branches, should be materially—very materially—larger than they have been in the past, if these men are not expected by outside activities to add to their incomes. I can, however, see no reason why the salary of a professor of medicine or surgery should be larger than that of a professor in a so-called scientific branch. In business circles it is true that the salary depends purely upon the immediate market value, so to speak, of the individual; that he who can in the world of affairs earn but a modest sum is able to demand a far smaller salary than a man with larger practical earning capacity. The physiologist who devotes himself single-heartedly to his teaching and his researches might, if thrown on the world to gain his living, have but a relatively small earning capacity; the clinician, if he have attained a popular reputation, may, on the other hand, be in a position to make a considerable revenue.

Universities often obtain the undivided services, let us say of the professor of physiology, for an amount which was once but is not to-day a proper living salary for a man whose abilities and contributions to science entitle him to a comfortable and prominent position in the community; that position which it is to the advantage of the university that he should occupy. And such professors in many institutions sacrifice much to the cause of science.

This seems to me fundamentally wrong. These distinctions must eventually be removed, unless our universities are to remain as short-sighted as our national government and bring it about that our professorships, like our diplomatic posts, shall come to be situations which only men of independent means can fill.

But to return to the question of the professorships in the clinical branches. If the salary be adequate, there should always be efficient men whose ambition will be to occupy chairs of medicine and surgery even though they realize fully that the chances of the acquisition of a large income are small.

The objection that is so commonly raised as to the injustice and unwisdom of any understanding or agreement by which the directors of the departments of medicine and surgery should abstain from private consulting practise is one which, as a teacher and practitioner, has interested me greatly. As has been indicated before, it is not easy to see how the director of a modern university clinic, or the chief of a service in a large hospital organized on a similar basis, can give any essential part of his time to outside consultations. According to the tastes and character of the man, he will

probably give more or less of his time to private consultations at his clinic. To the consultant the puzzling and interesting pathological problems brought for his consideration by patients sent to his consulting room by colleagues at home and abroad, form the most valuable part of his experience. Such patients the professor of medicine and his associates will doubtless continue to see. They should form a great addition to the hospital clinic. Some of these patients they will desire to admit to the hospital for study. But these consultations the director of a large clinic could hold only at stated periods, and to this work he could give only a limited amount of time. It is difficult to see how it would be possible for the director of such a clinic to give the proper service to his department, and yet conduct anything like an active consulting practise outside the institution. Under exceptional circumstances, however, the professor will probably accept calls to outside consultations, but only under exceptional circumstances. The director of a large medical department must control his own time and his engagements. He who is openly occupied in general or in consulting practise can never truly be master of his time.

A curiously active discussion has risen upon a rather small point in connection with the practise of the salaried director of a medical clinic. In some clinics, as has been said, the understanding exists that the professor shall contribute whatever fees he may collect from private patients to the departmental funds. This procedure has excited vigorous criticism and opposition; it has, indeed, been considered fundamentally improper, subversive of the higher interests and principles of the medical profession.

This is a problem on which I have meditated seriously, and, look at it as I may, I can not but regard it as a rather small and relatively unimportant detail of a larger general question. The professor should naturally demand suitable compensation for his services to private patients. But whether such compensation should go directly to him, or should be turned over by him to the budget of his department, seems to me a matter of detail to be settled between him and university or hospital. I am at a loss to understand the attitude of those who see in this a question of principle.

Some time before the first experiment of a university medical clinic was put into practise, a distinguished clinician whose services were sought by a well-known institution, offered independently, for the organization of his department a plan, which is very similar to that which now exists at the Johns Hopkins University. This offer outlined the establishment of his professorship upon a purely university basis, with the explicit understanding that the income from any private consultations into which he might see fit to enter, should be added to the budget of his department. Such an arrangement might be regarded as a distinct protection to the professor. For the financial questions which relate to practise are to some annoying and disturbing. And if the salary paid to the university professor be in any way sufficient, I can easily fancy that the professor might prefer to have it understood that the income from any practise which he might care to undertake should go into the budget of his department. I can also fancy that others might feel differently; that they might prefer a complete independence, expressed or implied, in this respect. I can further fancy that the university or hospital might fear that if the professor once began to accept fees from private patients, he would be in danger of being drawn into practise to such an extent that it would interfere with his

university or hospital work. But, as I have said, the question of what becomes of the professor's fees seems to me of limited importance—a detail in connection with the larger problem. I can not see in it a great question of principle.

So far as the student goes, the danger that under the direction of a salaried professor, he may be given a training more purely academic and insufficiently practical seems to me small. In the first place, it has already been pointed out that the professor of medicine will doubtless be a man who has had a considerable clinical experience with patients in all classes of life, whose training has been by no means purely academic, and although some of his associates will perhaps be men who have not yet acquired the ripened experience which should be that of the head of the department, yet no one for a moment fancies that *all* the instruction in medicine and surgery will be given by the nucleus of teachers wholly dependent on their salaries. In every large clinic, and in every large hospital affiliated with a university, a considerable part of the instruction in general medicine and surgery, as well as in specialties, must be entrusted to men with or without salaries, who are more or less actively engaged in practise. The fancy that because the director of such a clinic and many of his assistants are no longer at the beck and call of the public, the student is to be regarded as deprived of the opportunities offered by association with men who have been or are engaged in active practise, is a misconception.

That which the reorganization of a clinic upon a university basis should do, however, is to bring it about that the practitioners who share in the work and advantages of the hospital and take part in the instruction may be rather more carefully and wisely chosen than they have been in the past. Well-digested experience, merit and teaching ability should more clearly and surely be recognized by a director untrammelled by hospital traditions and bent solely on the improvement of his clinic.

The experienced clinician who is still engaged in private or consulting practise, if he be a man of high order, is not likely to lose his touch with the hospital or with the clinic so long as he is able and desirous of giving it his services. Indeed, it is probable that in the future, institutions will retain a closer connection with some of the members of the staff who are engaged in private consulting practise by offering them the privileges of consulting rooms at the hospital. This plan, which has already been adopted in some instances, ought to be of great mutual advantage to hospital, to physician and to patient. To the hospital because it brings into close connection with the clinic those examples of rare and unusual disease which are sent to the consultant; to the physician because he is able to give much more time to his work at the hospital; to the patient because if the consulting room of the physician be at the hospital center, the many accessory examinations which so often have to be made, can be carried out much more expeditiously. But if such a physician be engaged in active consulting practise, he will no longer be the director of the clinic, and this, as has been pointed out, would seem to be desirable from every standpoint. For only under exceptional circumstances can such a man command the time necessary properly to direct a full department.

How much or how little time the head of a department of medicine or surgery may give to consulting practise is, however, a question which in the end must depend entirely on the character of the man. He may give very little of his time; he may give a good deal. But if he be a man

whose living interest is in his clinic, it matters little. For in either instance, through the character of the men that he associates with him, he will see that his department does its best work.

The objection so often raised that there is danger that a professor of medicine or surgery who abstains from outside consulting practise may be removed from touch with the profession, is comprehensible but not, I think, serious. If the director of the department be one who does a considerable amount of clinical work, he will still keep in active touch with the medical profession even though his consultations be held only at the hospital. In any event, the work of the department itself, set forth by him and by his associates and assistants in public clinics, in medical societies, and in journals, should keep him well before the eyes of the medical world.

The tendencies of the hour would seem to indicate that a very large nucleus of the staff of the medical or surgical clinic will in the future consist of salaried men who are giving the greater part of their time to the activities of the department; and it is very interesting that not only in hospitals affiliated with university schools of medicine, but in other independent institutions, this idea has already taken root. The experiment of a generously salaried staff of physicians and surgeons who are expected to give the greater part of their time, if not their entire time to the institution, is already being made in various hospitals.

One of the most important functions of a modern medical or surgical clinic is that it should afford opportunities for the ambitious student with scientific aspirations to pursue that course of study and acquire that experience which will fit him for a university career. Every year there graduate from our schools of medicine men with the ideals, aspirations and abilities of the true student, who, because of financial disability, are obliged to enter directly into active practise. A certain number of these men preserve their enthusiasm, make the most of their opportunities, and return later to the pursuit of those studies which have always been the object of their ambitions. Some find unexpected intellectual satisfaction in the varied opportunities offered by the life of a practitioner. Others, dazzled by the financial rewards of success, lose their early ideals. Many, however, are obliged to sacrifice their ambitions. With the organization of the modern medical clinic, there should be a considerable number of assistantships commanding salaries which should make it possible for many of the really good men to pursue their chosen career. And it is highly desirable that such salaries should be sufficient and so graded that these men may continue their work through long years should they prove themselves of suitable character and ability.

But—and this is a question very often raised—what about the opportunities for the development of practitioners or consultants if every medical or surgical clinic become a training school for professors of medicine? The answer is simple. The training which best fits a man for a professorship differs in no way from that which best qualifies him for the career of a practitioner or consultant. Some of the men who start upon their career in a modern department of medicine will remain connected with the service in one capacity or another for ten or fifteen years or even more, until the offer of a position as assistant or professor or director in another large clinic comes to them. Many, after eight or ten years' experience, will find themselves well fitted to enter into the practise of medicine or surgery as consultants. Others after spending a shorter period of time will doubtless take up general or special practise. That to which we

may look forward with reasonable certainty, however, is that the reorganization of hospital and university clinics according to this general plan, the essential feature of which is the establishment of a large nucleus of salaried men who give the greater part of their time to the activities of their service, will provide for university, hospital and public a body of men better trained, and with richer experience than has been offered in times past.

There is one point in connection with the reorganization of the clinic upon what I have called a university basis which seems to me of real importance. This has been touched upon especially by Dr. Meltzer.[2] I refer to the desirability of ample provision for voluntary assistantships. This is a matter which touches especially hospital organization. The work of a modern hospital clinic has changed greatly. A well-organized medical or surgical clinic is as truly a scientific department as are the university departments of anatomy, physiology and chemistry, and in every hospital there is a constant demand for more and more students to assist in the researches which are being conducted by the various subdepartments, and incidentally in the care of the patients. The great advantage to a hospital of the presence of students in its wards has often been pointed out. Such students form a corps of extra assistants who enable us to study and care for our patients much more intelligently.

But where can one find the director of a medical clinic who is not longing for the services of more young men, recent graduates with scientific aspirations, to assist him in the study of a variety of different problems? As it is to-day, only those men who can obtain salaried positions upon the staff or are of independent means can afford to give the time required for such studies. But many a student, upon his graduation, and during the several years that follow, would be more than willing to accept a position as voluntary assistant if he might be given a room and his lodging in the hospital. Every modern medical or surgical clinic should have a number of these positions open to such men as the professor may see fit to select. There could be no better investment for the hospital. Research assistants should be considered as essential to the welfare of the hospital as are the regular internes.

[2] SCIENCE, 1914, XL., 620–628.

These are the considerations that I have wished to bring before you to-day. They have to do with matters which are not without public significance.

The relations of the medical sciences to the commonwealth are of great intimacy and of vital importance.

Time was when the physician was called upon only to minister to his ill or wounded fellow. To-day he is something more than the healer and the binder of wounds. The advice of the medical scientist is sought in every sphere of human activity. It is he who is called upon to outline and direct those measures which protect our homes from epidemic, our cities from pestilence. It is he who has opened the wealth of the tropics to the safe exploitation of man; to him we must look for that counsel which shall preserve the efficiency of our armies in the field and of our cohorts of industry at home; which shall lessen the horrors of war and the dangers of peace.

No effort can be too great; no sacrifice too costly that may afford to the student of the medical sciences the most active stimuli, the best opportunities for training and for research. For in the training of the student of medicine is involved more closely than is generally realized, the prosperity and safety of our country.

WILLIAM SYDNEY THAYER

406 Cathedral St.,
BALTIMORE

THE WORK OF THE JEFFERSON PHYSICAL LABORATORY

A synopsis of all the scientific investigations which have been carried on in the Jefferson Laboratory since its foundation in 1884 is beyond the scope of a brief notice. On the other hand, it is impossible to give a picture of our activities without a review of an extent sufficient to include the beginnings of those researches which are still in progress. Fortunately, it will not be necessary to go into much detail of description, since the eleven volumes of our "Contributions" contain a full account of all the results which have been obtained in the last dozen years.

The fact that this laboratory is not dominated by the work of any one man has led to a breadth of field in investigation rarely found in other similar institutions. The very number and variety of subjects, however, makes it difficult for a single individual to give an adequate account of the work as a whole. I have been freed from this difficulty by my colleagues, Professors Hall, Sabine, Davis and Bridgman, who have been kind enough to edit the account of their own researches.

Professor Hall's research work for many years has had to do with the flow of electricity and of heat in metals. He has published, usually in cooperation with others, various papers on thermal conductivity, on the Thomson effect, and on the electromagnetic and the thermomagnetic transverse or longitudinal effects in iron. Of late he has been occupied especially with the theories of electric and of thermal conduction, and of thermoelectric action, in metals. On this subject he published a paper in 1914, reaching the conclusion that "free electrons" play a much smaller part in conduction than many have supposed, but have an important function in thermo-electric action. In 1915, he published in *Il Nuovo Cimento* a short paper suggesting that the positive *ions* in a metal, probably as numerous as the free electrons, may have much to do in the maintenance of an electric current. He is now engaged in developing this idea.

Professor Sabine is continuing his investigations in the varied problems of architectural acoustics. The results, so far published, are proving of value to architects in the correction of auditoriums and in their design in advance of construction. At present the experiments relate to the transmission of sound through the structure. While Professor Sabine has been working in one field he has stimulated a number of students in a variety of different subjects. Some of the researches for which he was originally responsible are still in progress; of these the work of Professor Bridgman and the investigations in the Schumann region will be mentioned in detail presently.

The work of Professor G. W. Pierce on high-tension currents was for many years carried on in this laboratory. It is, therefore, a great temptation to add interest to this notice by including an account of it here. However, as Professor Pierce is now under his own roof, it seems only fair to allow him to describe the activities of his own laboratory, should he care to do so, at some future time.

Notwithstanding that a large part of the time of Professor Duane is taken up at the Huntington Hospital by his work on the application of the radiations from radioactive substances to the treatment of cancer, he is a most active contributor to the research output of this laboratory. He has himself written several articles, theoretical and experimental, on the subject of X-rays, Radioactivity and Atomic Theory during the past year and he is at present directing the experiments of four students in the same fields.

The establishment of standards of wavelength and the study of the emission of gases and solids in the Schumann region has occupied me for the last fifteen years; recently I have succeeded in extending the spectrum, in the extreme ultra-violet, beyond the limit set by Schumann by an amount greater than that which Schumann achieved. There still remains, however, a considerable gap to be bridged before the region of the softest X-rays is reached. Researches on the abiotic action of Schumann rays and a study of the volume ionization produced by them, have been completed in years past by Dr. Bovie and Pro-

fessor Frederic Palmer. Researches on the photoelectric effect and on the reflection of metals in the extreme ultra-violet are now being conducted by Dr. Sabine and Dr. Gardner.

Professor Davis is chiefly occupied with thermodynamics, his work on the thermal properties of steam being somewhat widely known through Marks and Davis's "Steam Tables." At the present time he and Mr. Kleinschmidt, a research student, are setting up the necessary apparatus for reproducing the international temperature scale with great precision by means of resistance thermometers, in the hope of verifying and completing some work of Professor Richard's along that line. Four other students have carried on experimental work under his direction; Dr. Trueblood on the Joule-Thomson effect in superheated steam, Dr. Romberg on the specific heat of water, Mr. Royster on the Joule-Thomson effect in thermometric gases, and Mr. Loomis on the thermal properties of mercury vapor. The first two of these researches are nearly ready for publication; the last two are still in progress.

The work of Professor Bridgman is perhaps as well known as that of any member of our staff. I am indebted to him for the following summary: The thermodynamic properties of matter have been investigated under three main headings. The first heading has to do with the properties of liquids that do not freeze up to 12,000 kg. The chief results were these: nearly all the liquids show a reversal of dilatation at high pressure, the dilatation at the higher temperatures becoming less than at lower temperatures. Beyond a certain pressure, the repulsive forces between the molecules predominates over the attractive forces so that work is stored up as pressure is increased. All liquids show persistent individual variations, doubtless in some way connected with specific molecular properties. The second heading has to do with melting curves. By examination of some 20 liquids, the characteristics of their melting curves at high pressure have been established; neither of the two theories, formerly accepted as correct, is true. The melting curve neither ends in a critical point nor passes through a maximum, but continues to rise indefinitely, approaching a straight line at high pressure. The third heading has to do with polymorphic changes of solids. Some 150 substances have been examined and the phase diagrams of 30 substances have been studied and a number of new modifications have been found. The relations are most complicated and do not tend to any common type of behavior at high pressure. It is the rule that the phase of smaller volume is more compressible than the phase of greater volume and there are a number of cases in which the phase stable at higher pressures has a smaller specific heat. It can be definitely proved by these results that, at least in many cases, the centers of attractive force between the molecules are not located at their geometrical centers, but are probably close to the surface.

Dr. Chaffee's chief interests lie in the same field as those of Professor Pierce, but, as part of his work is still carried on in this building, it is fair to claim his study of oscillatory circuits as a product of this laboratory; as one result of this investigation he has perfected the "Chaffee Gap" a device of wide utility in wireless telegraphy.

Among the junior members of the teaching staff, Dr. D. L. Webster has recently turned his attention to the experimental study of characteristic X radiation; thanks to the generosity of the General Electric Company, and by the use of the laboratory's 40,000-volt storage battery, he has already obtained some important results from a rhodium target. Dr. Clark has been at work on the study of the vibrations in a stretched wire; he is at present engaged in the design and construction of a deep-sea thermometer. Dr. Nusbaum is engaged upon the study of hysteresis loss in iron at very high frequencies.

There are in all twelve candidates for the doctorate at present at work on pieces of research or on theoretical problems; the fields of study of five of these men have been already mentioned; of the other seven, four are working in spectroscopy, a subject for which we are

particularly well equipped, two are in electrodynamics and one in the study of viscosity of liquids.

The building in which all these researches are conducted is more than thirty-two years old, but, all things considered, it still serves its purpose very well. This is all the more remarkable when it is remembered that at the time when it was built there were few laboratories, either here or abroad, to serve as models. It is to the foresight of Professor John Trowbridge that the successful design of the Jefferson laboratory was largely due and it was his unselfish energy which made its equipment possible. Those who work in the building should ever keep these facts gratefully in mind.

Theodore Lyman

Cambridge

SCIENTIFIC NOTES AND NEWS

The Society of American Bacteriologists will meet at New Haven on December 26, 27 and 28. There will be an adjourned meeting in New York on December 29 in affiliation with Section K of the American Association. Members of program committee who have been requested, in opening the sessions under their charge, to review the work done in America in their field in bacteriology are as follows: Professor C.-E. A. Winslow, characterization and classification; Dr. F. G. Novy, protozoology; Professor C. E. Marshall, agricultural bacteriology; Professor F. P. Gorham, industrial bacteriology; Professor E. O. Jordan, sanitary bacteriology; Dr. W. H. Park, human pathology; Dr. V. A. Moore, comparative pathology; Dr. Erwin Smith, phytopathology, and Dr. D. H. Bergey, pedagogics of bacteriology. Those who have accepted invitations to speak at the dinner are Dr. A. C. Abbott, Dr. Herman M. Biggs, Professor H. W. Conn, Dr. J. J. Kinyoun, Professor W. T. Sedgwick, Dr. Theobald Smith, Dr. V. C. Vaughan and Dr. W. H. Welch.

To celebrate the eighty-sixth birthday (May 6) of Dr. Abraham Jacobi a dinner was given at the Ritz-Carlton, New York. Dr. Jacobi, emeritus professor of diseases of children in Columbia University, is in active hospital and private practise in New York City.

Dr. Raymond Dodge, professor of psychology in Wesleyan University, has been appointed by the trustees of Columbia University to be Ernest Kempton Adams research fellow for the academic year 1916–17.

At its meeting held May 10, 1916, the Rumford Committee of the American Academy of Arts and Sciences voted a grant of $500 to Professor R. A. Millikan, of the University of Chicago, in aid of his researches on the photoelectric properties of metals in extreme vacua.

A grant of $300 has been made from the C. M. Warren Fund of the American Academy of Arts and Sciences to Professor Grinnell Jones, of Harvard University, for work on the free energy of chemical reactions.

The British Institution of Civil Engineers has made the following awards for papers read and discussed during the session of 1915–16: A Telford gold medal to Sir John Benton (Eastbourne); a Watt gold medal to Sir George Buchanan (Rangoon); a George Stephenson gold medal to Mr. F. W. Carter (Rugby), and Telford premiums to Mr. C. Carkeet James (London), Mr. D. E. Lloyd-Davies (Cape Town), and Mr. W. T. Lucy (Oxford).

The two annual Walker prizes in Natural History offered by the Boston Society of Natural History were this year awarded as follows: a first prize of one hundred dollars to Wilbert Amie Clemens for his essay entitled "An Ecological Study of the May-fly, *Chirotenetes*," and a second prize of fifty dollars to Carl Cheswell Forsaith, for his essay on "The Relation of Peat Deposits to the Formation of Coal." These prizes are annually offered for the best memoirs submitted on subjects in natural history, and while the composition is open to all, it was the intent of the founder of the prizes, the late William Johnson Walker, that they should serve as an encouragement for younger naturalists, rather than as a reward for mature investigators.

DR. R. HAMLYN-HARRIS, director of the Queensland Museum, has been elected president of the Royal Society of Queensland.

PROFESSOR E. M. LEHNERTS, of the University of Minnesota, has succeeded D. Lange as president of the Minnesota Forestry Association.

DR. R. WILLSTÄTTER, professor of chemistry at Berlin, has been elected a foreign member of the Swedish Academy of Sciences.

DR. FREDERICK TAYLOR has been reelected president of the Royal College of Physicians, London.

DR. ARTHUR D. LITTLE, of Boston, has been placed in charge of the bureau, which was organized recently in Montreal for the purpose of coordinating the work of scientific men and experts engaged in scientific research in all parts of the Dominion of Canada.

DR. RALPH H. MCKEE has resigned his position as professor of chemistry in the University of Maine, to become head of the research department of the Tennessee Copper Company with laboratory headquarters at Ridgefield Park, N. J.

S. B. HASKELL has resigned as professor of agronomy in the Massachusetts College, to engage in commercial work.

CONTINUING the policy which has been in effect in Nela Research Laboratory for the past two summers, the following three men have accepted invitations to pursue research work in the laboratory during the coming summer: Professor Ulric Dahlgren, professor of biology, Princeton University; Dr. W. E. Burge, acting head of the department of physiology, University of Illinois, and Dr. Jakob Kunz, associate professor of physics, University of Illinois. Dr. Edward O. Hulburt, of the Johns Hopkins University, has been appointed Charles F. Brush fellow in physics in the laboratory for the summer of 1916.

ACCORDING to a press dispatch the British government has decided to organize an expedition for the relief of Sir Ernest Shackleton's Antarctic expedition.

PROFESSOR RICHARD P. STRONG, of Harvard University, who is a member of the Serbian Distress Fund Committee, is returning to Europe in a few days for the purpose of making arrangements for relieving the distress of native civilians, who have been unable to leave Serbia. A fund will be raised for this relief and also for that of the Serbians who have left.

THE third medical unit to be sent by Harvard to relieve the present university contingent in Europe will be composed of twenty-three surgeons, nearly all graduates of the Harvard Medical School. The unit, led by Dr. Hugh Cabot, '94, will sail for England on the Cunard liner, *Andania*, on May 20.

MESSRS. ALFRED H. BROOKS, SIDNEY PAIGE, H. G. FERGUSON and J. FRED HUNTER, JR., of the U. S. Geological Survey, have joined the military training camp to be held at Dodge, Ga., from May 3 to June 1.

PROFESSOR THEOBALD SMITH, of the Rockefeller Foundation for Medical Research, Princeton, New Jersey, will deliver the second Mellon lecture under the auspices of the Biological Society for Medical Research of the University of Pittsburgh, in the Mellon Institute for Industrial Research on May 17. The subject of the address will be "Certain Aspects of Natural and Acquired Resistance to Tuberculosis and their Bearing on Preventive Measures."

THE following addresses dealing with various phases of human and animal nutrition have recently been given before the Washington Academy of Sciences:

Dr. C. L. Alsberg, "The Biochemical Analysis of Nutrition."

Dr. Eugene F. Du Bois, "The Basal Food Requirement of Man."

Dr. Graham Lusk, "Nutrition and Food Economics."

Dr. E. B. Forbes, "Investigations on the Mineral Metabolism of Animals."

Dr. Carl Voegtlin, "The Relation of the Vitamines to Nutrition in Health and Disease."

The addresses will be published in the *Journal* of the Washington Academy of Sciences and reprinted in a collected form.

THE Scientific Association of the Johns Hopkins University was addressed on May 11

by Dr. Ira Remsen on "Chemistry and the Present War."

At the Case School of Applied Science, Dr. L. A. Bauer, of the Carnegie Institution of Washington, will, on May 23, give the lecture at the open meeting of the Society of Sigma Xi, his subject being "The Earth a Great Magnet and the Work of the Non-magnetic yacht *Carnegie*."

Professor Raymond Dodge, of Wesleyan University, spent the time from May 6 to 8 in consultation with the bureau of applied psychology at the Carnegie Institute of Technology, and delivered a lecture on "Some Psychological Effects of Alcohol."

Professor E. M. Freeman, assistant dean of the college of agriculture of the University of Minnesota, gave the Sigma Xi address at the University of Wisconsin on April 26. His subject was "Wheat Rust Investigations."

The Philadelphia Academy of Surgery announces that essays in competition for the Samuel D. Gross prize of $1,500 will be received until January 21, 1920. Full information may be obtained by writing to the trustees, 19 South Twenty-second Street, Philadelphia.

Sir Alexander R. Simpson, for many years professor of midwifery in the University of Edinburgh, bequeaths the museum formed by his uncle, the late Sir James Young Simpson, the discoverer of chloroform as an anesthetic, to the University of Edinburgh. He had previously given his uncle's and his own libraries to the Royal College of Physicians, Edinburgh.

The bronze tablet placed in St. Paul's Cathedral to the memory of Captain Scott and his companions was unveiled on May 5.

Professor I. P. B. Menschutkin, of the Polytechnic Institute, Petrograd, writing on March 20, informs *Nature* that Professor Pawlow is alive and well. The obituary notices which appeared in scientific and medical journals were, as has been suggested in Science, due to confusion with E. W. Pawlow, a Petrograd surgeon, who died in February.

John Edson Sweet, who was professor of practical mechanics at Cornell University from 1873 to 1879, died in Syracuse, N. Y., on May 8, aged eighty-four years.

William Stanley, known for his work in electrical engineering, died at Great Barrington, on May 14, in his forty-ninth year.

Dr. S. M. Brickner, known as a gynecologist and for his work in anatomy, physician at the Sloane Maternity Hospital and at the Mt. Sinai Hospital, until his retirement to Saranac Lake three years ago, died on May 5, at the age of forty-eight years.

Dr. Edward Leaming, formerly instructor in photomicrography in Columbia University, known for his contributions to this subject and the X-rays, died on May 11, aged fifty-four years.

Major W. L. Hawksley, health officer at Liverpool and known for his work on tuberculosis, has been killed while on active service in France.

The death is announced of Professor O. Maass, of the University of Munich, known for his experimental work on sponges.

Dr. Richard Braungart, professor of agriculture in the Bavarian Academy of Agriculture, has died at the age of seventy-seven years.

Mrs. Frances Thome, widow of the late director of the Argentine National Observatory at Cordoba, died recently in Buenos Aires. During over twenty years' residence at the observatory she took part in recording for the Durchmusterung, observing, and in various details of copying and preparation for the press of this work, and of the meridian results.

The London *Daily Chronicle* for April 24 as quoted in *Nature* gives the substance of a letter sent to Professor Lorentz, of Haarlem, by Dr. Max Planck, professor of mathematical physics in the University of Berlin, and permanent secretary of the Royal Prussian Academy of Sciences. In this letter Professor Planck recalls the letter addressed to the civilized world in August, 1914, by ninety-three German scholars and artists, in which they defended the conduct of their own government, and denounced in extravagant language

the action of the allies. Professor Planck himself was one of the signatories. He is now said to admit that the form in which this letter was written led to regrettable misunderstandings of the real sentiments of the signatories. In his opinion, and it is an opinion shared, he says, by his colleagues Harnack, Nernst, Waldeyer and Wilamowitz-Möllendorff, that letter of appeal was written and signed in the patriotic exuberance of the first weeks of the war. It must not be taken for granted, says Professor Planck, that at the present time anything like a scientific judgment can be formed with regard to the great questions of the historical present. "But what I wish to impress on you," he writes to Dr. Lorentz, "is that notwithstanding the awful events around us, I have come to the firm conviction that there are moral and intellectual regions which lie beyond this war of nations, and that honorable cooperation, the cultivation of international values, and personal respect for the citizens of an enemy state are perfectly compatible with glowing love and intense work for one's own country."

UNIVERSITY AND EDUCATIONAL NEWS

BY the will of Charles W. Harkness, who died on May 1, Yale University will receive $500,000. There are also bequests to the Presbyterian Hospital of $100,000 for endowment purposes, and $250,000 to be added to the Harkness Fund for scientific and educational work.

A BEQUEST of $150,000 has been made to the Johns Hopkins University by Miss Jessie Gillender for the purpose of instituting organized research into the problem of epilepsy.

THE Long Island College Hospital, Brooklyn, announces that after January 1, 1918, the completion of two years of study in a college of liberal arts or science will be required for admission to the four-year medical course leading to the degree of M.D. At present the requirement is one year only of college work. Beginning in the fall of 1916 Columbia University, New York, will conduct a pre-medical college year at the Long Island College Hospital.

MR. ARTHUR DU CROS, M.P. for Hastings, has promised a gift of £7,000 to the extension fund of the London School of Medicine for Women, thus completing the £30,000 for which appeal was made.

CLYDE BROOKS, A.B., Ph.D., M.D., has resigned his post at the University of Pittsburgh Medical School and has accepted the position of professor and head of the department of physiology, pharmacology and physiological chemistry in the school of medicine of the University of Ohio, at Columbus, Ohio. This marks the beginning of a plan to be carried out by the newly elected dean, Dr. E. F. McCampbell, in reorganizing and developing the medical school at Columbus. The plan includes the erection of a new university hospital and a new medical building on the university campus.

AT Harvard University the following appointments to the staff of the medical school have been made: Ernest E. Tyzzer, to the George Fabyan professorship of comparative pathology; Charles J. White, to the Edward Wigglesworth professorship of dermatology, and Arthur D. Hill, to a professorship of law. Percy G. Stiles has been promoted to be assistant professor of physiology, and Dr. James H. Wright, assistant professor of pathology.

AMONG the new appointments at the University of Chicago is that of George Van Biesbroeck, adjunct astronomer of the Royal Observatory of Belgium, as professor of practical astronomy at Yerkes Observatory. Promotions include the following: To a professorship: Henry Gordon Gale, of the department of physics. To associate professorships: Harvey Carr, of the department of psychology, and Preston Kyes, of the department of anatomy. To assistant professorships: Joseph W. Hayes, of the department of psychology, and Wellington D. Jones, of the department of geography.

IN the department of zoology of Columbia University, Dr. William K. Gregory, now associate, has been promoted to be assistant pro-

fessor of vertebrate paleontology. He will retain his position at the American Museum of Natural History.

Professor Ernst Gaupp, of Königsberg, has accepted a call to the chair of anatomy at Breslau.

DISCUSSION AND CORRESPONDENCE

AGE OF THE TUXPAM BEDS

In Science of February 10, 1911, the writer gave a preliminary sketch of the Tertiary deposits of northeastern Mexico. In this communication the beds occurring in the vicinity of Tuxpam with their wealth of fossils, which appeared to be largely new or undescribed species, were stated to probably belong to the Miocene, and this reference has been followed in later publications both by himself and by others.

While both gasteropods and bivalves were abundant at this locality, the most characteristic fossils of these beds were the echinoderms, which included great numbers of a very large *Clypeaster*, one or more species of *Schizodus, Macropneustes* and *Cidaris*. None of these special forms were reported by other observers from the region to the south of Tecolutla, but the similarity of the deposits of the lower coastal area seemed to indicate their continuity, and since such fossils as had been described from these continuations were considered of Miocene or Pliocene age, it seemed probable that the Tuxpam beds were also of that age.

During the examinations made in the coastal area between Tuxpam and Tampico since this publication, numerous collections of fossils have been made and these are now being examined. We find that the Tuxpam *Clypeaster, Cidaris* and *Macropneustes* occur elsewhere in connection with the nummulites, cristillaria and orbitoides of the Oligocene, but where we find this association we do not find the large number of gasteropods and bivalves which are found at Tuxpam, or on the San Fernando. The shells usually accompanying these echinoderms around Tampico are simply a small pecten, a nucula, and one or two small gasteropods. In some localities imprints of leaves are abundant in the accompanying shales.

Such an association of fossils seems to require the reference of the Tuxpam beds to the Oligocene, and if this be true, it would appear that along the western gulf shore there is no marine Miocene on the surface between Tuxpam and Galveston. E. T. Dumble

NITER SPOTS

To the Editor of Science: In a recent number of Science[1] is to be found an article by Sackett and Isham relating to the formation of "niter spots" in the arid regions of the western United States. In a more recent number of the same magazine[2] Stewart and Peterson have given a lengthy and interesting discussion of this paper and also a description of these brown spots. These later writers have attributed the origin of these nitrates to the leaching and concentrating action of irrigating water upon the nitrates occurring in the shales and sandstones (or country rock) adjacent to and underneath the affected areas from which the soil has been derived. Their field observations were in Utah, where they describe the appearance of brown "niter spots" in certain irrigated fields.

While making some geological investigations in northwestern Nevada in 1912 it was the present writer's pleasure to make some notes relating to brown "niter spots" occurring on the playas. The observations being in strict conformity with well-known principles of commercial niter formation, the necessity of much speculation before arriving at a conclusion as to their origin was obviated. It is trusted that the few simple facts recorded at that time will serve in giving some added light on the subject in hand.

In traversing the playas brown spots were frequently noted on the surface in connection with alkali salts. When the brown mixtures of earth and salts were tested they invariably showed large amounts of nitrates. In places on the surface where the brown color was not present no nitrates were noted. Pits dug failed to show nitrates at greater depths than

[1] N. S., Vol. XLII., p. 452.

[2] N. S., Vol. XLIII., pp. 20–24.

two to three inches beneath the surface. Jack rabbits inhabited the areas in great numbers and it was first observed that wherever alkaline waters had come in contact with their feces the water, which usually held in small puddles, took on a dark brown color not unlike that of the waters holding in many unclean barnyards after a rainstorm. The decomposition of the fecal matter appeared to be comparatively rapid when in contact with the alkaline waters or with the moist alkali soil and air. The animal refuse was observed in all stages of decomposition from the fresh droppings to the complete disappearance of the original organic material. With the evaporation of the waters which had been in contact with this refuse the soil took on the brown color noted and responded to tests for nitrates. Fecal matter from cattle and horses was later observed undergoing the same type of decomposition and producing similar brown spots containing nitrates. All of the water on the playas examined was of an alkaline nature.

Since these observations are in harmony with the established principles of niter formation in India there was no hesitation in concluding that the brown "niter spots" of the playas were, as far as examined, of animal origin.

From these Nevada observations it is safe to predict that in fields of the arid western states brown "niter spots" will appear when live stock is pastured in the same and alkaline waters are used for irrigation. In this connection it would be important to know if live stock was pastured in the fields in which Stewart and Peterson made their observations. This fact would seemingly have an important bearing on their conclusions.

WALTER STALDER

SAN FRANCISCO, CALIF.

SCIENTIFIC BOOKS

Historical Introduction to Mathematical Literature. By G. A. MILLER, Professor of Mathematics in the University of Illinois. New York, The Macmillan Co., 1916. Pp. xiii + 302.

This valuable work is decidedly unique. It is not a history of mathematics, yet contains much accurate historical information. It is not a bibliography of mathematics, yet it says much about books, journals and dictionaries. It is not a volume on mathematical recreations, yet is most interesting reading. It is not a philosophy of mathematics, though it illumines such matters as Betrand Russell's definition of mathematics as "the subject in which we never know what we are talking about nor whether what we are saying is true." It is not a collection of biographies, though brief sketches of twenty-five leading mathematicians are given in one of the chapters. The book gives much miscellaneous information on recent mathematical activity in different countries of the world. The organization of mathematical societies, the starting of mathematical journals, the trend of modern thought along the lines of arithmetic, algebra, geometry and analysis, are all presented in a popular and pleasing manner, by one who is able to take a broad view of the mathematics of to-day. Attention is given to topics of general interest, such as Fermat's last theorem, magic squares, systems of numeral notation, women mathematicians, the international commission on the teaching of mathematics. The purposes of the book, as expressed in the words of the author, are "to meet the needs of a text-book for synoptic and inspirational courses which can be followed successfully by those who have not had extensive mathematical training. It may also be used as a text-book for a first course in the history of mathematics, especially by those teachers who believe with its author that such a first course should largely concern itself with recent mathematical events and developments." This aim is achieved in an eminently satisfactory manner. The book meets a real want.

The list of books on the history and the teaching of mathematics, recommended by the author, is selected more particularly to meet the needs of English readers. This list makes it painfully conspicuous that there are at present no up-to-date general histories of mathematics in the English language. The best general histories are in the German language. In

recent years much criticism has been passed upon Moritz Cantor's monumental work, written in German, yet nothing approaching it exists in the English language. Cantor is now in his eighty-seventh year and is nearly blind. If the revisions of his volumes which were planned before the war, and were to be executed by younger men, are carried out, then his history will doubtless maintain an undisputed supremacy for many years to come. Professor Miller says that Tropfke's work is "getting too old to be entirely reliable." Tropfke himself stated last spring to the present writer that his history needed revision. But Miller's criticism on Tropfke's history applies with even greater force to the general histories written in the English language.

Florian Cajori

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Colorado Springs, Colo.

Dyestuffs and Coal Tar Products. Their Chemistry, Manufacture and Application. By Thomas Beacall, B.A., F. Challenger, Ph.D., B.Sc., Geoffrey Martin, Ph.D., M.Sc., B.Sc., and Henry J. S. Sand, D.Sc., Ph.D. Pub. D. Appleton and Co. 8vo. 156 pages, 29 fig.

The critical situation which developed in the textile, leather and other industries on account of the shortage of dyes, as well as in the pharmaceutical and photographic trades on account of a similar shortage of synthetic drugs and organic chemicals was largely responsible for the publication of this book. It is virtually a reprint with certain revisions and additions of chapters from "Industrial and Manufacturing Chemistry," Vol. 1, edited by Geoffrey Martin, on the following subjects:

"Industry of Coal Tar and Coal Tar Products."
"Industry of the Synthetic Coloring Matters."
"Industry of Natural Dyestuffs."
"The Dyeing and Color-Printing Industry."
"Modern Inks."
"Saccharine and other Sweetening Chemicals."
"The Industry of Modern Synthetic Drugs."
"The Industry of Photographic Chemicals."

The field covered is so broad and presents such extreme possibilities of theoretical and practical details that the present publication can only be looked upon as a résumé. To those having a knowledge of organic chemistry a study of the book will serve as a valuable review and a foundation for further study. A valuable feature of the book is the bibliography at the introduction of each chapter.

L. A. Olney

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PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The third number of volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *The Mechanics of Intrusion of the Black Hills (S. D.) Pre-Cambrian Granite:* Sidney Paige, U. S. Geological Survey, Washington, D. C.

2. *On the Fossil Algae of the Petroleum-Yielding Shales of the Green River Formation of Colorado and Utah:* Charles A. Davis, Bureau of Mines, Washington, D. C.

Scientific, as well as economic interest has been aroused in these shales, because they have recently been discovered to yield petroleum when subjected to destructive distillation in closed retorts. The author finds that these shales may be examined microscopically by the methods of sectioning already in use for peats and coals.

3. *Archeological Explorations at Pecos, New Mexico:* A. V. Kidder, Department of Archæology, Phillips Andover Academy.

The most important results are stratigraphical; various styles of pottery being found in superposition.

4. *Man and Metals:* Walter Hough, U. S. National Museum, Washington, D. C.

An account is given of the author's study of the uses of fire by man in so far as the development of metallurgy is concerned.

5. *On the Observed Rotations of a Planetary Nebula:* W. W. Campbell and J. H. Moore, Lick Observatory, University of California.

The nebula No. 7009 of Dreyer's New General Catalogue is rotating about an axis

through the central nucleus nearly at right angles to the plane passing through the observer and the major axis of the image. The mass of the nebulæ is apparently several times larger than that of the sun. It is suggested that the ring nebulæ are not true rings, but ellipsoidal shells.

6. *A Short Period Cepheid with Variable Spectrum:* HARLOW SHAPLEY, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The star *RR* Lyræ is a periodic variable in at least three ways: first, in the light intensity; second, in the radial velocity; and third, in the spectrum which changes from F to A. A similar spectral change is found in *RS* Boötis.

7. *The Spectrum of δ Cephei:* WALTER S. ADAMS and HARLOW SHAPLEY, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

At maximum the high temperature lines are very strong and the low temperature lines very weak; while at the minimum the reverse is the case. This indicates that at maximum the temperature of the gases of the star's absorbing envelope is higher than at minimum.

8. *Investigations in Stellar Spectroscopy. I. A Quantitative Method of Classifying Stellar Spectra:* WALTER S. ADAMS, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Method replaces to a considerable extent direct estimations of spectral type by numerical estimates of relative line intensity which may be made with much higher accuracy.

9. *Investigations in Stellar Spectroscopy. II. A Spectroscopic Method of Determining Stellar Parallaxes. III. Application of a Spectroscopic Method of Determining Stellar Distances to Stars of Measured Parallax:* WALTER S. ADAMS, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The method of computing absolute magnitudes and parallaxes from the variation of the intensities of lines in the stellar spectrum is capable of yielding results of a very considerable degree of accuracy.

10. *Investigations in Stellar Spectroscopy. IV. Spectroscopic Evidence for the Existence of Two Classes of M Type Stars:* WALTER S. ADAMS, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Two groups of M stars are indicated clearly by examination of the intensities of the hydrogen lines.

11. *The Failure and Revival of the Process of Pigmentation in the Human Skin:* A. E. JENKS, Department of Sociology and Anthropology, University of Minnesota.

It is found that on the one hand, there is an extension of the albinistic areas and on the other a revival of the process of pigment metabolism within an at-one-time albinistic area.

12. *Banded Glacial Slates of Permo-Carboniferous Age, showing possible Seasonal Variations in Deposition:* ROBERT W. SAYLES, University Museum, Harvard University.

A study of the slate and tillite formations of Squantum (near Boston) affords evidence of seasonal changes in the locality, indicating that it was in a temperate zone during Permian times as now.

13. *An Extension of Feuerbach's Theorem:* F. MORLEY, Johns Hopkins University.

All circular line-cubics on the joins of four orthocentric points touch the Feuerbach circle.

14. *Deformations of Transformations of Ribaucour:* L. P. EISENHART, Department of Mathematics, Princeton University.

15. *Geographic History of the San Juan Mountains since the Close of the Mesozoic Era:* WALLACE W. ATWOOD and KIRTLEY F. MATHER, Geological Museum, Harvard University.

The study of the geography of this region is closely related to the geologic studies of the range, but may lead also to a study of anthropogeography.

16. *The Age of the Middle Atlantic Coast Upper Cretaceous Deposits:* W. B. CLARK,

E. W. Berry and J. A. Gardner, Geological Laboratory, Johns Hopkins University.

The several Upper Cretaceous formations of the Middle Atlantic Coast represent all of the major divisions of the European series.

17. *Upper Cretaceous Floras of the World:* Edward W. Berry, Geological Laboratory, Johns Hopkins University.

The stratigraphic position of the more important of the Upper Cretaceous floras is indicated by a diagram.

18. *Observations on Amœba Feeding on Infusoria, and their Bearing on the Surface-Tension Theory:* S. O. Mast and F. M. Root, Zoological Laboratory, Johns Hopkins University.

Surface-tension is probably only a small factor in the process of feeding in Amœba.

19. *The Electromotive Force produced by the Acceleration of Metals:* Richard C. Tolman and T. Dale Stewart, Department of Chemistry, University of California.

Successful attempts have been made to change the relative position of positive and negative electricity in a piece of metal by subjecting it to a large retardation.

Edwin B. Wilson
Mass. Institute of Technology,
Boston, Mass.

SPECIAL ARTICLES

THE KATA THERMOMETER AS A MEASURE OF THE EFFECT OF ATMOSPHERIC CONDITIONS UPON BODILY COMFORT

It has been clearly demonstrated by numerous investigations that the objectionable effects of the air of a badly ventilated room are chiefly thermal rather than chemical in nature. At the same time it has been recognized that the ordinary thermometer is a very inadequate measure of the discomfort experienced in such a room because the heat loss from the body surface is influenced not only by the temperature of the surrounding air but also by the humidity present and the radiant heat which reaches the body, and above all by the movement of the air. The condition in a close room has been commonly compared with that which obtains outdoors on a muggy day in summer; yet it is clear that the outdoor temperature must be very much higher than the indoor temperature in order to produce a comparable degree of discomfort.

Dr. W. Heberden[1] pointed out these facts nearly a hundred years ago and suggested a way out of the difficulty by the observation of the rate of fall of a thermometer previously heated to a high temperature. He heated a thermometer to 100° F. and noted the number of degrees which it fell in ten minutes as a measure of "sensible cold." He records drops of from 8° to 22° in the first ten minutes.

The same device has recently been independently worked out by Dr. Leonard Hill in England[2] and the apparatus is now sold by Siebe Gorman and Company of Chicago under the name of the Kata thermometer.

The Kata thermometer outfit consists of two specially constructed thermometers with large bulbs and stems graduated from 86° to 110° F., one to be used as a dry and the other as a wet bulb thermometer. The bulbs are heated to about 110° and then placed in clips which hold them in a horizontal position, after drying the bare bulb on a clean cloth and jerking excess moisture off the silk covered one. The time taken to fall from 100° to 90° is then noted, best by the use of a stop-watch.

The rate of fall of both thermometers will obviously be affected by air movement and radiant heat as well as by air temperature, and that of the wet bulb by the humidity of the air as well. Dr. Hill believes that the combined influence of these factors will affect the Kata thermometers very much as it does the human body, and suggests a one-minute period for the wet bulb and a three-minute period for the dry bulb as upper limits for comfortable atmospheric conditions.

This instrument promises to be of so much assistance in the practical study of ventilation

[1] "An Account of the Heat of July, 1825; together with Some Remarks upon Sensible Cold," *Trans. Roy. Soc.*, London, 1826, Part II., p. 69.

[2] "The Physiology of the Open-Air Treatment," *The Lancet*, CLXXXIV., May 10, 1913, p. 1,283; see also O. W. Griffith, "Ventilation and Housing," *The Medical Officer*, XIII., June 19, 1915, p. 273.

problems that I have made a number of observations to determine how closely its records correspond with sensations of bodily comfort. These observations are presented in Tables I., II. and III. The first series was made indoors and outdoors in the country at Ipswich, Mass., during the month of August; the second in my laboratory at the American Museum of Natural History in New York (with and without the air current from a desk fan); and the

TABLE I[3]

Observation	Date	Shade Temperature	Kata Times, Seconds. Dry Bulb	Kata Times, Seconds. Wet Bulb	Comfort Vote[4]	Remarks
1	7/8	73°	118	44	2.5	Porch, under awning. Light wind.
2	7/8	73°	237	55	3.5	Same as 1 but in direct sun.
3	7/8	77°	216	90	3.8	Indoors, table, under lamp.
4	8/8	68°	82	36	2.0	Porch. Cloudy day. Moderate wind.
5	10/8	75°	128	50	3.0	Porch, in shade of house. Clear, after rain. Light breeze.
6	10/8	75°	268	42	3.8	Same as 5 but in sun. More breeze.
7	11/8	74°	227	72	3.0	Indoors. Draft from open door.
8	13/8	75°	196	67	3.7	Porch. Cloudy. Air very damp. Light wind.
9	13/8	75°	105	43	2.7	Same as 8 but at end of porch in stronger breeze.
10	14/8	79°	188	48	3.4	Porch in shade. Moderate breeze.
11	14/8	80°	255	80	4.0	Same as 10 but out of wind.
12	16/8	82°	180	42	3.7	Porch in shade. Light wind.
13	17/8	72°	115	23	2.2	Porch in shade. Strong breeze.
14	21/8	77°	143	48	3.6	Porch in shade. Light breeze.
15	21/8	77°	159	37	3.4	Same as 14. Porch in sun. Sky clouded. More breeze.
16	22/8	89°	49	25	2.0	Porch. Cloudy day. High wind.
17	23/8	79°	320	94	4.7	Indoors. Five people and lamp in room.
18	29/8	66°	176	67	2.2	Indoors. Closed room. Rain outside.
19	29/8	72°	277	78	3.6	Indoors. Before fire.

[3] Observations made during month of August, 1915, at Ipswich, Mass.

[4] Average of vote of three to six observers, including four women, ages 90, 65, 38 and 36 and two men, ages 38 and 75.

TABLE II[5]

Observation	Date	Shade Temperature	Kata Times, Seconds Dry Bulb	Kata Times, Seconds Wet Bulb	Comfort Vote[6]	Fan[7]
20	1/9	71°	177	68	3.2	——
21	Do.	70°	78	25	2.6	First speed.
22	3/9	79°	355	95	3.7	——
23	Do.	79°	118	29	2.7	Half speed.
24	15/9	88°	720	148	4.8	——
25	Do.	87°	215	50	4.0	Half speed.
26	Do.	87°	223	45	3.8	Over third speed.
27	17/9	88°	844	131	4.5	——
28	Do.	88°	260	41	4.0	Half speed.
29	23/9	72°	233	69	3.8	——
30	Do.	72°	72	25	2.8	Half speed.
31	28/9	69°	200	71	3.4	——
32	Do.	69°	71	22	2.6	Half speed.
33	29/9	72°	220	62	3.2	——
34	Do.	72°	84	28	2.7	Half speed.
35	6/10	72°	240	75	3.6	——
36	Do.	72°	72	28	2.6	Half speed.

TABLE III[8]

Observation	Date	Shade Temperature	Kata Times, Seconds Dry Bulb	Kata Times, Seconds Wet Bulb	Comfort Vote[9]	Remarks
37	22/10	66°	200	62	3.1	One window open. Sun shining.
38	Do.	67°	181	52	3.0	Later. Windows closed. Sun clouded. Fan on.[10]
39	2/11	61°	122	48	2.2	Windows closed. Fan on.
40	5/11	61°	151	52	3.0	Windows closed. Fan on.
41	5/11	64°	148	49	2.9	Later. Fan off.
42	12/11	65°	159	55	3.2	Windows closed. Fan on.
43	12/11	67°	185	64	3.1	Later. Fan off.
44	26/11	69°	170	58	3.4	Windows closed. Fan on.
45	26/11	71°	196	51	3.4	Later. Fan off.

[5] Observations made in laboratory of Department of Public Health, American Museum of Natural History, New York, September and October, 1915.

[6] Average of vote of 3 to 6 observers, all males from 16 to 38 years of age.

[7] First observation on each date made in laboratory with windows closed. Second (and third of September 15) under same conditions but with a 15-inch colonial desk fan operating about 4 feet from thermometers and directed toward them.

[8] Observations made in physiological laboratory, Yale Medical School, through courtesy of Professor Yandell Henderson.

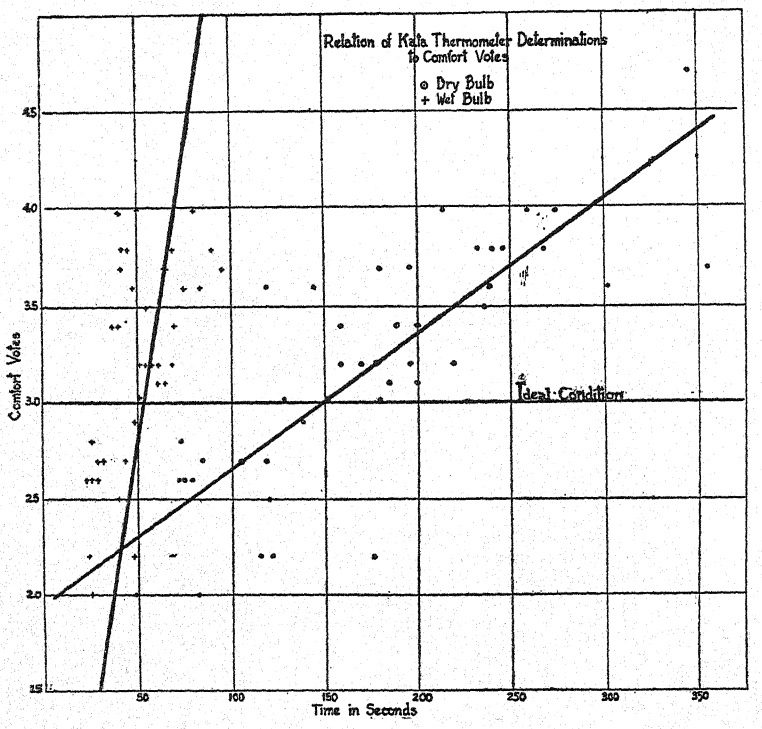
[9] Average of vote of 10 to 20 medical students.

[10] 22-inch exhaust fan in corner of ceiling.

third series in the physiological laboratory of the Yale Medical School, through the courtesy of Professor Yandell Henderson.

At the time each observation was made, from three to twenty observers were asked to express their opinion as to the comfortableness of the atmospheric conditions on a scale of five as follows: 1, cold; 2, cool; 3, ideal; 4, warm; 5, hot. The comfort vote in the table represents the average of the observers voting on each occasion.

With these exceptions the plotted points are not at all badly grouped about the calculated line, considering that we are dealing with so variable a factor as the sensation of comfort. A study of individual points which deviate widely from the straight line shows that of twelve cases in which the atmospheric conditions were voted as hotter than would be expected from the thermometer readings, every one was either outdoors in a wind or indoors in front of the electric fan (observations 6, 8, 10, 12, 14, 15, 21, 25, 26, 28, 30, 32). Of thirteen cases in which the atmospheric conditions were voted cooler than would be expected from the reading, on the other hand, only four were cases in which there was a strong current of moving air (observations 1, 3, 4, 7, 13, 16, 18, 19, 22, 33, 37, 38, 39). This probably means that whereas the ordinary thermometer leaves out entirely the effect of air movement, the Kata thermometer emphasizes it somewhat unduly.



The results of the comfort vote have been plotted against wet and dry bulb readings in the diagram, the straight lines representing the most probable curve as calculated from individual observations. Two records out of the forty-five (Nos. 24 and 27) have been omitted since these very high values (12 minutes and 14 minutes, respectively, for the dry bulb) fell far below the curve. The comfort vote fails to express such extreme conditions adequately.

On the whole, however, it seems clear that this instrument is of great value in measuring the actual influence of air conditions upon the body and is greatly superior to the ordinary thermometer for this purpose. Compare for instance observations 8 and 9, both made outdoors on a cloudy day, with an air temperature of 75°. In 8 the Kata thermometers and the observers were protected from the wind, while in 9 they were at the end of the porch in a breeze. The dry bulb times at these two points were 196 seconds and 105 seconds, respectively, and the comfort votes 3.7 and 2.7. In the first case it was uncomfortably warm, in the second too cool, with nothing in the reading of the ordinary thermometer to indicate any change. Again contrast observations 13 and 19, the first taken out of doors in a strong breeze, the second indoors before a fire. The ordinary thermometer registered 72° in each case, but in one instance the time for the fall of the Kata dry bulb was 115 seconds and the comfort vote 2.2; in the other case the dry bulb time was 277 seconds and the comfort vote 3.6. Out door conditions with ordinary thermometer readings of 75° (Nos. 5 and 9), 77° (No. 15), and 79° (No. 10) were more comfortable and showed lower Kata thermometer times than this room with a fire at 72°.

Most significant are the readings and the comfort votes in Table II., in which on each day conditions were noted, first without, and then with, the direct draft from an electric fan. In each case the ordinary thermometer either remained unchanged (or dropped one degree in two instances) while the Kata times and the comfort votes fell off enormously. On six different days, with ordinary thermometer readings varying from 69° to 79°, the comfort vote showed uncomfortably hot conditions and Kata dry bulb times over 170 without the fan and too cool conditions, and Kata dry bulb times under 120 with the fan turned on (observations 20–23 and 29–36). Even the condition of 87° on the ordinary thermometer (observation 26) was as comfortable and showed about the same Kata thermometer readings as were obtained without the fan at an air temperature of 72° (observation 29).

The curves as plotted suggest that the optimum for comfort (represented by an average vote of 3.0) falls close to the lower of the points suggested by Dr. Hill (45–60 seconds for the wet bulb and 150–180 seconds for the dry bulb). Too much stress can not of course be laid on a small number of observations such as are here reported, but the general value of the Kata thermometer seems sufficiently obvious to warrant its general use in the study of atmospheric conditions as they affect bodily comfort.[11]

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YALE MEDICAL SCHOOL

THE AMERICAN PHILOSOPHICAL SOCIETY

THE general annual meeting of the American Philosophical Society was held on April 13, 14 and 15 during which nearly fifty papers were presented on a great variety of topics. The address of welcome was made by Dr. W. W. Keen, the president, who, with vice-presidents W. B. Scott and E. C. Pickering, presided at the various sessions.

On Friday evening a reception was held at the hall of the Historical Society of Pennsylvania, after which Dr. L. O. Howard, of Washington, gave a lecture "On Some Disease-bearing Insects."

Saturday afternoon was entirely devoted to a symposium on international law in its various aspects, five papers being presented.

The program and some abstracts of the papers follow:

THURSDAY, APRIL 13

Opening Session—2 o'clock

William W. Keen, M.D., LL.D., President, in the Chair

The Popes and the Crusades: DANA C. MUNRO.

The Common Folk of Shakespeare: FELIX E. SCHELLING.

A Rare Old-Slavonic Missal: J. DYNELEY PRINCE.

On the Art of Entering Another's Body: A Theme of Hindu Fiction: MAURICE BLOOMFIELD.

[11] Hill, Griffith, and Flack (*Phil. Trans. Roy. Soc. Lond.*, series *B*, Vol. 207, pp. 183–220) have recently published an important study in which the Kata readings are translated into fundamental physical units of millicalories of heat loss per square centimeter per second.

The Isles of the Blest: PAUL HAUPT.

The Interpretation of Mythology: FRANZ BOAS.

America's Relation to the Developments of International Law: LEO S. ROWE.

Sight and Signaling in the Navy: ALEXANDER DUANE. (Introduced by Dr. Geo. E. de Schweinitz.)

Observations of the Mentality of Chimpanzees and Orangutans. (Illustrated with motion pictures.) WILLIAM H. FURNESS, 3D.

THURSDAY EVENING, APRIL 13

Meeting of the officers and council at 8:30 o'clock.

FRIDAY, APRIL 14

Executive Session—9:30 o'clock

Proceedings of the officers and council submitted.

Morning Session—9:35 o'clock

William B. Scott, Sc.D., LL.D., Vice-president, in the Chair

Two New Terms, Cormophytaster and Xeniophyte, Axiomatically Fundamental in Botany: WILLIAM TRELEASE.

Origin and Vegetation of Salt Marsh Pools: JOHN W. HARSHBERGER.

The Work of the Mellon Institute in its Relations to the Industries and to the Universities: RAYMOND F. BACON.

The F_2 Generations, and Back-, and Inter-crosses of the F_1 Hybrids between Œnothera nutans and pycnocarpa: GEORGE F. ATKINSON.

In the F_1 generation of the cross *Œnothera nutans* × *Œ. pycnocarpa* there appear four hybrid types, *Œ. nutella, Œ. pycnella, Œ. tortuosa* and *Œ. tortuella.* In the F_1 of the reciprocal cross three hybrid types have thus far appeared which are identical with three of the types named, viz., *nutella, pycnella* and *tortuella.* It is probable that if the number of individuals was very large, *tortuosa* would also appear.

Of these four F_1 hybrid types, *nutella* is a blend, and thus far has proved absolutely self-sterile, though the pollen works on *pycnella* and *tortuosa* (it has not been tried on *tortuella,* on both of the parents, and on all other species of *Œnothera* on which it has been tried. The egg cells are also fertile in reciprocal crosses with the same forms. *Pycnella, tortuosa* and *tortuella* are, on the other hand, "segregate" hybrids; *i. e.,* they select certain characters from each parent and develop them to their full expression. *Pycnella* and *tortuosa* are "counterparts," *i. e.,* the two together use all the characters of both parents, the one making use of the characters which the other omits. *Tortuella* appears to have all the characters of *tortuosa* except the red stem which comes from the parent *nutans, tortuella* having the green stem of the parent *pycnocarpa,* which is also inherited by *pycnella.* The hybrids *pycnella* and *tortuosa* are fixed in the F_1 generation, they breed true in the F_2 generation (*pycnella* has been tried in the F_3 and breeds true). *Tortuella,* however, appears to split in the F_2 generation. This result is remarkable that in the F_1 generation from a cross between two feral, non-mutating species, quadruplet hybrids appear in the F_1 generation; one is a blend and self-sterile, but its pollen and egg cells are fertile; two of the segregates are fixed types and breed true, while the fourth hybrid (3d segregate) appears to split in the second generation. The back- and inter-crosses show, either striking examples of patrocliny, or splitting into two types in some cases, into three types in other cases. But no new types (with a single exception) appear, they all conform to one or other of the six types, the primary parental types, or one or more of the F_1 hybrid types. The single exception is a mutant of the dwarf *gracilis* type.

Inheritance through Spores: JOHN M. COULTER.

The current work in plant genetics suggests the question of the most favorable material. In the main, the most complex plants have been used, so that it is impossible to analyze the factors involved. Even the origin of the embryo is not always assured, on account of the frequent occurrence of apogamy. Furthermore, only inheritance through sexual reduction is secured. If sexual forms are desirable, it seems obvious that the most primitive ones should be included in experimental material, since in such forms the sex act is not involved with other structures, the origin of the sexual cells is observable, and the whole situation lends itself to more complete control and analysis. The sexual cells, however, are genetically related to spores, so that the origin of spores and their behavior in reproduction is preliminary to the origin of gametes and sexual reproduction. Reproduction spores, therefore, is a field rich in experimental possibilities. Analysis of the conditions of spore formation furnishes a clue to the additional conditions necessary for gamete formation; experimental modification of the "germ plasm" is more simple and definite than in com-

plex material; and breeding from spores with essentially pure lines is especially favorable for securing more definite data in reference to the possibilities of variation and inheritance.

The Dynamics of Antagonism: W. J. V. OSTERHOUT.

If two toxic substances antagonize each other we call this action antagonism. An accurate measure of antagonism is afforded by determining the electrical resistance of living tissues. Toxic substances cause a fall of resistance, but if in a mixture of two such substances resistance falls less rapidly, it is evident that this is due to antagonism. In the case of the common kelp *Laminaria* NaCl causes a fall of resistance while $CaCl_2$ causes a rise followed by a fall of resistance. In mixtures of NaCl and $CaCl_2$ the resistance rises and then falls; by using the right proportions the fall may be made very gradual. We may explain these facts by assuming that the resistance is due to a substance, the production of which is accelerated by $CaCl_2$ while its decomposition is checked by a compound formed by the union of both NaCl and $CaCl_2$ with a substance in the protoplasm. This throws new light on the manner in which salts act in preserving life. It has been found that the electrical resistance is a very delicate and accurate indicator of the vitality of protoplasm, since any kind of injury is at once indicated by a fall of resistance. This permits us to give a quantitative meaning to such terms as vitality, injury, recovery and death. The mechanism by which changes in resistance are produced by salts is therefore of great importance. The facts here presented give us a new insight into this mechanism.

Jointing as a Fundamental Factor in the Degradation of the Lithosphere: FREDERICK EHRENFELD. (Introduced by Professor Amos P. Brown.)

This paper is a study of those physical activities which are always at work to bring the surface of the earth down to a level or nearly flat surface. It includes also some discussion concerning the probable destruction of former great land masses or continents such as those believed by geologists to have existed formerly across the present oceans connecting Europe, Africa and America. In most text-books of the science the question of land surface leveling or degradation is considered more from the standpoint of the atmospheric or other surface cause than from the point of the construction of the solid portions of the earth itself. This the author of this paper considers a somewhat mistaken view to take of the case, as the stony mass or portion of the earth has been shown by many geologists to be subject to a constant fracturing or jointing which shows itself in various ways such as influence on river drainage, repeated groups of islands, bays along sea coasts and in certain types of volcanic and earthquake appearances. The paper discussed these and also the subject of marine planation to produce a lowering of the land below sea level. Illustrations of such marine action were shown from the Maine coast and also from the forms and positions of some of the Atlantic ocean islands. This subject of the action of the sea to produce a general leveling though a much discussed one some decades ago has been neglected by many modern students, but is now becoming prominent under newer ideas of the science, and this paper is in part a study of jointing in the mass of the lands to assist in such action and hasten continental land leveling and destruction by creating in the rock mass through joints great lines of weakness which under the attack of both the atmosphere and the sea compel the falling apart of the land. The question of former great land masses was discussed, as was also the bearing of these joints in the subject of the formation of coral reefs. In conclusion the author proposed a "law of joints" in which the controlling influence of joint lines was more definitely stated.

Sinking Islands versus a Rising Ocean in the Coral-Reef Problem: WILLIAM MORRIS DAVIS.

Since Darwin's voyage in the *Beagle*, eighty years ago, nearly all geologists who adopted his theory of coral reef accepted also his postulate that the reef-bearing islands have subsided with the subsiding ocean bottom. In later years, and largely under the leadership of the Austrian geologist, Suess, and the German geographer, Penck, the possible variation of ocean level around fixed islands has been emphasized. When it is seen that a rise of the ocean surface around still-standing islands would produce all the conditions that arise from Darwin's postulate of subsiding islands in an ocean of constant level, search should be made for some means of evaluating these two alternatives. The result of such a search shows that the theory of a changing ocean involves many extravagant complications which have not been sufficiently considered by those who accepted it; while the theory of subsiding islands is relatively simple and economical. Darwin's original theory is to be preferred on those grounds.

The Petrology of Some South Sea Islands and its Significance: Joseph P. Iddings.

The islands of Tahiti, Moorea, Huaheine, Raiatea, Tahaa, Bora Bora of the Society group, and Hiva-oa and Nukahiva of the Marquesas were visited in order to ascertain whether the volcanic rocks composing them are of such a character that they support the theory of isostasy, which demands that the deep portions of the earth's crust, or the lithosphere, under the Pacific Ocean should consist of heavier material than that underlying the continent of North America. It was found that the volcanic rocks of these islands are noticeably heavier on the average than the igneous rocks occurring in various parts of the American continent. Each of the islands visited was found to be an extinct basaltic volcano, considerably eroded, and partly submerged beneath the sea. The structure and rocks of the islands are briefly described and characteristic views are shown by means of lantern slides.

Coal Formation: J. J. Stevenson.

The doctrine that the fossil fuels from peat to anthracite are a continuous series has been subject of renewed discussion within recent years. The writer felt compelled to make serious investigation to free himself from doubts aroused by the statements of some authors. The study proved unexpectedly difficult, for the disputants have very little common ground and one can hardly determine what kind of evidence may be acceptable to all. Some collateral matters, of much importance, have been overlooked and little information exists respecting them. These are chiefly chemical and the studies require extensive equipment as well as expenditure of much time, neither of which is at the writer's disposal. But assurances have been received from the presidents of several great organizations that the investigations will be made and that the results will be in readiness for the final summary. The general study has advanced so far, in the writer's opinion, as to justify presentation of the first part of his monograph. The plan adopted is to discuss the fuels in order of age, beginning with peat and closing with the Paleozoic coals. The first part considers peat and the Tertiary coals; the second will consider the Mesozoic and the Paleozoic coals. The writer hopes to make evident the inherent probability of the doctrine that, in spite of difference in plant materials, the coals throughout form a connected series, not merely in mode of accumulation, but also in physical structure and in chemical composition.

California Lakes and the Solar Hypothesis of Climatic Changes: Ellsworth Huntington.

Color Photographs of the Phosphorescence of Certain Sulphides: Edward I. Nichols.

By the use of a new form of phosphorescope the author has succeeded in taking photographs by the Lumière process, which shows the colors of certain phosphorescent sulphides of the Lenard and Klatt series. The change of tint by decay and the striking changes of color produced by cooling to the temperature of liquid air are exhibited by means of these photographs and the theory is very briefly discussed.

Friday, April 14

Afternoon Session—2 o'clock

William B. Scott, Sc.D., LL.D., Vice-president, in the Chair

A New and very Sensitive Indicator for Acidimetry and Alkalimetry and for Determining Hydrogen Ion Concentrations between the Limits of 6 and 8 on the Sorensen Scale: G. Scatchard and Marston T. Bogert.

The authors have discovered that dinitro benzoylene urea (dinitro 2-, 4-diketotetrahydroquinazoline $\rightleftharpoons$ dinitro 2-, 4-dihydroxyquinazoline) is an unusually sensitive indicator and one which can be prepared easily, in any desired amount, from anthranilic acid. It changes from colorless to greenish yellow with a change in hydrogen ion concentration from 10^{-6} to 10^{-8}, the development of the coloring following regularly the decreasing concentration of hydrogen ion. It is very little affected by neutral salts or proteins, and not at all by the ordinary biological preservatives, chloroform and toluene. The color does not fade perceptibly in two days, and but very slightly in a week. It therefore promises to be very useful in the measurement of hydrogen ion concentration of biological or other liquids in this important range, for which the previously known indicators are not very satisfactory. It is possible with it to detect the effect of one drop of N/100 NaOH in 100 c.c. of solution, and titrations of N/100 HCL with N/100 NaOH checked within 0.L per cent. Under similar conditions -nitrophenol required 5 to 6 drops, and methyl orange 10 to 12 drops, to give a sure end-point. Its chief objection is its yellow color, which renders it unsuitable for determinations in artificial light.

Bacterio-chemical Studies of Decay of the Teeth: William J. Gies.

The Human Gastric Secretion: Martin E. Rehfuss. (Introduced by Dr. Philip B. Hawk.)

Cerebral Localization: HARVEY CUSHING. (Introduced by Dr. Keen.)

The Inorganic Constituents of Marine Invertebrates: FRANK WIGGLESWORTH CLARKE.

It is a commonplace of geology that many limestones are formed from the remains of marine animals, such as corals, mollusks, crinoids, etc. Some of these limestones are magnesian, some are phosphatic and others are of the ordinary type, consisting chiefly of calcium carbonate. They were originally deposited at the bottom of the sea, and their composition depends upon the composition of the organisms which formed them. The present investigation has for its purpose to determine what each group of organisms contributes to the sediments; and in order to answer this question nearly 250 analyses have been made of the shells or skeletons of marine invertebrates, covering a range from the foraminifera up to the crustacea, and including also the corellin algæ. It was already well known that corals and molluscan shells were composed almost entirely of calcium carbonate, and that fact has been verified. The shells of one group of brachiopods, however, consist largely of calcium phosphate, and that substance is also abundant in the crustacea. These animals, and also vertebrate skeletons, contribute phosphates to the sediments. The foraminifera, alcyonaria, sea fans, echinoderms and calcareous algæ, with some minor groups or organisms, contain much magnesia, and therefore aid in the formation of magnesian limestones. Curiously enough, the amount of magnesium carbonate in any series of organisms varies with the temperature of the water in which the creatures lived; being small in cold and large in warm waters. A sea urchin from Greenland, for example, contained 6 per cent. of magnesium carbonate, and one from near the equator contained over 13 per cent. In certain algæ from the West Indies 25 per cent. was found. Furthermore, some organisms have their calcium carbonate in the form of aragonite, and others consist of calcite. The aragonitic organisms are all non-magnesian; while the magnesian forms are all calcitic. The data obtained in this investigation have been applied to the study of coral reefs, which owe their composition to all the creatures living upon them, and not to the corals alone. In fact, the corals are often of less importance than their associates.

Some Properties of Vibrating Telephone Diaphragms: A. E. KENNELLY and H. O. TAYLOR.

(A) Dimensional Gases and the Law of Reflection of Gas Molecules from Solid Walls. (B) The Metallic Reflection of Light from a Gas: ROBERT WILLIAMS WOOD.

Some Relations between Matter and Radiation: WILLIAM DUANE. (Introduced by Professor A. W. Goodspeed.)

To Benjamin Franklin we owe the fundamental conception that the phenomena of nature are due largely to the interaction of atoms of electricity with atoms of ordinary matter, and the object of this paper is to discuss the emission of radiant energy (light, heat-rays, X-rays, etc.) from the point of view of Franklin's conception. Since the discovery, some years ago, of cathode rays, X-rays and radioactivity scientists have had in their hands the means of producing and studying streams of atoms of both electricity and ordinary matter. They have succeeded even in observing effects due to a single atom of each kind. We now know that the impacts of atoms of electricity against atoms of ordinary matter produce radiation. Mr. Hunt, Dr. Webster and the author have been investigating the relations between the energy of the atom of electricity and the frequency of the radiation it produces. The most striking facts we discovered are that in the case of the so-called *general radiation* the energy required is strictly proportional to that frequency, and in the case of the so-called *characteristic radiation* the energy required is larger than in the preceding case and not always proportional to the frequency. The author offered the following explanations of these facts. High frequency vibrations are associated with the central parts of an atom of matter, in which the electromagnetic field is very strong. In order to reach a point in an atom of matter where a given frequency of vibration is produced the atom of electricity must have at least enough energy to overcome a certain force of repulsion acting between them. If we follow out the line of reasoning and apply Maxwell's distribution law and what has been called the fourth power law to the case of the atoms of electricity flying about in a hot body owing to its thermal agitation, we arrive at an equation for the distribution of energy in the spectrum that represents the facts with considerable precision. The above mentioned laws discovered by experimental investigation have a practical bearing on X-ray phenomena also. They indicate what must be done in order to produce those very high frequency radiations that hitherto have been obtained from radioactive substances only.

Relation between Changes in Solar Activity and the Earth's Magnetic Activity, 1902–1914: Louis A. Bauer.

No criterion of solar activity, whether it be the spottedness of the sun, or the faculæ, prominences, or calcium flocculi, has been found to synchronize precisely with any quantity used as an index of the earth's magnetic activity. Thus, for example, the maximum magnetic activity in 1892 preceded the maximum sunspot activity of that period by a year. So again the recent minimum magnetic activity of the earth seems to have occurred in 1912, whereas the minimum sunspot activity did not take place until 1913, or a year later. Then again the amount of magnetic activity is not necessarily commensurate with that of solar activity, whatever measure of the latter be used. When the comparisons between the solar data and the magnetic data are made for intervals of less than a year, a month for example, as was done in my paper before this society in 1909, the lack of exact synchronism and the lack of proportionality between the two sets of changes become especially noticeable. Fortunately, beginning with 1905, we have a new set of figures, the values of the solar constant, determined with high precision at Mount Wilson, California, by Dr. Abbot. Remarkable fluctuations are shown in these values, amounting at times to 10 per cent. of the value. The present paper makes a comparison between the annual changes in the values of the solar constant for the period 1905 to 1914 with the irregularities in the annual changes of the earth's magnetic constant. It is found that the two sets of data, in general, show similar fluctuations. Also, a closer correspondence is found between those two sets of changes than between either set and that of sunspot frequencies. In brief, the solar-constant values furnish another index of changes in solar activity which may be usefully studied in connection with minor fluctuations in the earth's magnetism. In conclusion, it was pointed out why none of the mentioned criteria of solar activity can be used as an adequate measure of the various ionizing agencies ultimately responsible, according to present belief, for the magnetic changes recorded on the earth.

FRIDAY EVENING, APRIL 14

Reception from 8 to 11 o'clock at the hall of the Historical Society of Pennsylvania, S.W. corner of Locust and Thirteenth Streets, at 8:15 o'clock. Leland O. Howard gave an illustrated lecture "On Some Disease-bearing Insects."

SATURDAY, APRIL 15

Executive Session—9:30 o'clock

Stated Business.—Candidates for membership balloted for. As a result of the election the following were elected as members of the society:

Residents in the United States

William Wallace Atterbury, A.M., Radnor, Pa.; Maxime Bôcher, A.B., Ph.D., Cambridge, Mass.; Percy William Bridgman, Ph.D., Cambridge, Mass.; James Mason Crafts, S.B., LL.D., Boston, Mass.; Henry Platt Cushing, Cleveland, Ohio; Edward Murray East, M.S., Ph.D., Boston, Mass.; Frank Rattray Lillie, Ph.D., Chicago, Ill.; William E. Lingelbach, A.B., Ph.D., Philadelphia; Daniel Trembly MacDougal, A.M., Ph.D., Tucson, Ariz.; Charles Frederick Marvin, M.E., Washington, D. C.; Lafayette Benedict Mendel, A.B., Ph.D., Sc.D., New Haven, Conn.; Forest Ray Moulton, Ph.D., Chicago, Ill.; Eli Kirk Price, A.B., LL.B., Philadelphia; Erwin Frink Smith, Sc.D., Washington, D. C.; William Morton Wheeler, Ph.D., Boston, Mass.

Foreign Residents

Frank Dawson Adams, D.Sc., Ph.D., F.R.S., Montreal; Wilhelm L. Johannsen, M.D., Ph.D., Copenhagen; Joannes Diderik van der Waals, Ph.D., Amsterdam.

Morning Session—10 o'clock

Edward C. Pickering, D.Sc., LL.D., F.R.S., Vice-president, in the Chair

Age Cycles and Other Periodicities in Organisms: C. M. Child. (Introduced by Professor C. E. McClung.)

Experiments with various forms among the lower invertebrates show that senescence occurs in those forms as in the higher animals, but that rejuvenescence also ocurs in asexual reproduction, in the reconstitution of pieces experimentally isolated and also during starvation. These organisms may pass through alternating periods of senescence and rejuvenescence without death and often without reproduction. The experimental evidence indicates that senescence consists physiologically in a decrease in the general metabolic rate, conditioned by the modifications of the colloid substratum and the progressive accumulation of relatively stable structural substances during growth and differentiation. Rejuvenescence is physiologically an increase in general metabolic rate conditioned by the chemical breakdown and removal of such modifications under certain physiological conditions. The sex cells are physiologically old, highly differentiated cells and the early stages of embryonic de-

velopment constitute a period of rejuvenescence. Many other periodicities in organisms are of the same general nature as the age cycle. Fatigue, recovery, the loading and discharge of gland cells, various seasonal periodicities, alternating active and quiescent periods, etc., depend to a greater or less degree on modifications of the protoplasm by metabolism and the following removal of such modifications under altered metabolic conditions.

Cooperation as a Factor in Evolution: WILLIAM PATTEN. (Introduced by Professor H. H. Donaldson.)

The purpose of this discussion is to show that cooperation, or the summation of power, is the creative and preservative agent in evolution, and that the summation of power depends on cooperation in the conveyance of power. The *vis a tergo* in life is the product of internal cooperative exchange (metabolism). Growth is profitable exchange, or the increase of the power of exchange due to the local accumulation of those agents whose demands are the impetus to exchange. The rate at which growth proceeds depends on the capacity of its conveyers, that is on their capacity to convey things to and from the growing points, or the growing points to the sources of supplies. Growth creates a power which is used as a means to satisfy its own demands, and a surplus power for "freedom" of action, which is used to experiment and explore, or to find better ways and means of satisfying its demands. Growth, therefore, follows the easiest, most accessible, and most profitable lines of conveyance, and its products accumulate along the lines of least resistance. Growth inevitably creates diversified conditions which tend to check its own progress till relieved by better cooperation. For growth reduces the immediately available supplies, thereby requiring greater expenditures to procure them; and the new internal conditions created by growth create new products, with new demands, faster than the right ways of ministering to them can be found. The larger demands, under reduced resources, can only be supplied by better cooperation in the common service of conveyance; but as fast as these demands are satisfied, producing new growths, further demands are created, to satisfy which requires still better methods of cooperation. The same laws which prevail in the inner and outer life of animals and plants prevail in the social life of man. Man's social progress is measured by the degree to which he has extended the mutually profitable give and take of cooperative action beyond himself, to the family, tribe, state and into the world of life at large. The chief agents of civilization, language, commerce, science, literature, art and religion are the larger and more enduring instruments of conveyance, which better enable the part and the whole to avoid that which is 'evil" and to find that which is "good," and which yields a larger surplus for "freedom."

On the Effects of Continued Administration of Certain Poisons to the Domestic Fowl, with Special Reference to the Progeny: RAYMOND PEARL.

Types of Neuromuscular Mechanism in Sea-Anemones: GEORGE H. PARKER.

In the origin of nerve and muscle the sea-anemone has been supposed to represent a step in which a nervous set of very primitive structure could throw into prolonged contraction the general musculature of the animal's body. An examination of the body of the sea-anemone shows that its muscular activities are of a much more diverse kind. They include, first, muscles that act under direct stimulation and without the intervention of nerves; secondly, muscles that are stimulated directly as well as by nerves; thirdly, muscles that are stimulated only by nerves and exhibit under these circumstances profound tonic contractions; and, finally, muscles that react in the same reflex way that those in the higher animals do. This diversity of muscular response has not been fully appreciated by previous workers.

Determination of Stellar Magnitudes by Photography: EDWARD C. PICKERING.

An immense amount of work is being carried on by observatories all over the world, in determining the photographic magnitudes of the stars. It is of the utmost importance that all of these magnitudes should be reduced to the same scale. Accordingly, in April, 1909, an International Committee was appointed with members from England, France, Germany, Holland, Russia and the United States. This committee met in 1910 and 1913, and, after a most amicable discussion, agreed on a system, in which all stars were to be referred to a Standard Sequence of stars near the North Pole. The magnitudes of the latter were determined at Harvard by Miss H. S. Leavitt, by six different methods, using eleven different telescopes, having apertures from one half to sixty inches. All gave accordant results, and were adopted by the committee. A simple method was found for transferring these magnitudes to stars in other parts of the sky, but here extraordinary sources of systematic errors presented themselves. For in-

stance, if two equal exposures were made on a plate, the second was found to give fainter images; if, by means of a small prism, exposures were made simultaneously with different apertures, the smaller aperture indicated a brighter magnitude than the larger, when the stars were bright, and a fainter magnitude when they were faint. The color equation was found to vary by different amounts not only for different instruments, but for different magnitudes.

Monochromatic Photography of Jupiter, Saturn and the Moon. (Illustrated by Color-photographs made with the Mt. Wilson 60-inch telescope): Robert Williams Wood.

On the Eclipses of Jupiter's Satellites: John Q. Stewart. (Introduced by Professor H. N. Russell.)

On the Probable Temperature of Mars: Henry Norris Russell.

A New Catalogue of Variable Stars: Annie J. Cannon. (Introduced by Professor E. C. Pickering.)

The first variable star was discovered in 1596, and two hundred years later, when the first Catalogue was made, there were but twelve known. A catalogue of 113 variable stars was published in Germany in 1865. In 1888 when the first catalogue of them was made in America, the list contained 225 stars. About this time, the Harvard photographic work was established by the director, E. C. Pickering. One of the first results of a study of these photographs was the discovery of large numbers of variable stars. They were found by four methods: by arranging groups of stars in sequences; by the presence of bright lines in their spectra, when photographed with an objective prism; by multiple exposures on the same stars throughout the whole night; and by superposing a glass positive and negative of the same region. The globular clusters, the Magellanic clouds, and the map of the sky have proved fruitful fields for this investigation. So great has been the increase in number that a new Catalogue now being compiled contains 4,641 stars, of which 3,397, or nearly three quarters of the whole, have been found at Harvard, and 1,244 elsewhere, by astronomers in nearly all portions of the civilized world. The variable stars are divided into five classes, dependent upon the character of their variation in light. The periods vary from two hours to 698 days. Determination of the periods and light curves of these stars constitute a large piece of work. Much has been done at Harvard in this field, and many observations have been furnished other astronomers for such determinations. No more suitable place could be found for the preparation of this catalogue than the Harvard Observatory, for the rich library of a quarter of a million stellar photographs furnishes the only complete material in the world for the study of these stars during the last twenty-five years. By examining the past history of a star on these photographs, the investigator may far more readily find an answer to such perplexing questions as to whether a star is variable or constant, what is the length of the period, is the period changeable, what is the color or the spectrum of the star, than by waiting months or years to accumulate additional observations.

Legal and Political International Questions and the Recurrence of War: Thomas Willing Balch.

SATURDAY, APRIL 15

Afternoon Session—2 o'clock

William W. Keen, M.D., LL.D., President, in the Chair

Symposium on International Law: Its Foundation, Obligation and Future:

Outline: Hon. John Bassett Moore.

Judicial Aspects: International Arbitration: Hon. Charlemagne Tower.

Legislative Aspects: George Grafton Wilson. (Introduced by Hon. John Bassett Moore.)

Administrative Aspects: Philip Marshall Brown. (Introduced by Hon. Charlemagne Tower.)

World Organization: Hon. David Jayne Hill.

On Saturday evening, April 15, at 7:30 o'clock, the annual dinner was held in the North Garden of the Bellevue-Stratford, at which more than one hundred members and guests were present. The president was particularly happy and witty in his introductions of the speakers, who responded to the toasts as follows:

"The Memory of Franklin," by Professor A. Trowbridge.

"Our Sister Societies," by Professor R. A. Millikan.

"Our Universities," by Professor J. M. Coulter.

"The American Philosophical Society," by Professor F. E. Schelling.

Thus ended perhaps the most notable meeting since the Franklin Celebration.

Arthur W. Goodspeed

Philadelphia,
April 17, 1916

SCIENCE

FRIDAY, MAY 26, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE VOLCANIC HISTORY OF LASSEN PEAK[1]

WILL there be another great volcanic explosion from the summit of Lassen Peak this spring? is a burning question among those scientists who are studying the recent performance of that old volcano. A feeble explosion May 30, 1914, opened a new period of volcanic play, and on May 19 and 22, 1915, the greatest and most devastating eruptions occurred. As these dates are about the time of maximum annual snow-melts at Lassen Peak, they suggest a causal relation to the volcanic activity. If so, perhaps another large eruption may be due in May, 1916, and throw more light on the volcanic problem.

Lassen Peak is in northeast California and forms the southern end of the Cascade Range. It stands between the northern end of the Sierra Nevada and the Klamath Mountains, a mighty volcano that rises to an elevation of more than a mile above the early Tertiary and Cretaceous sedimentary rocks on which it rests. It is on the edge of one of the greatest lava fields in the world, extending from northern California, Oregon and Washington eastward across Idaho into the Yellowstone National Park of Wyoming, and covering an area of about 250,000 square miles. Over the eastern portion of this field most of the lava is basalt, which was very liquid at the time of its eruption and, spreading far and wide like water, it formed a flattish country, the great plains of Snake River and the Columbia, but along the western border the lava

[1] Published by permission of Director of U. S. Geological Survey.

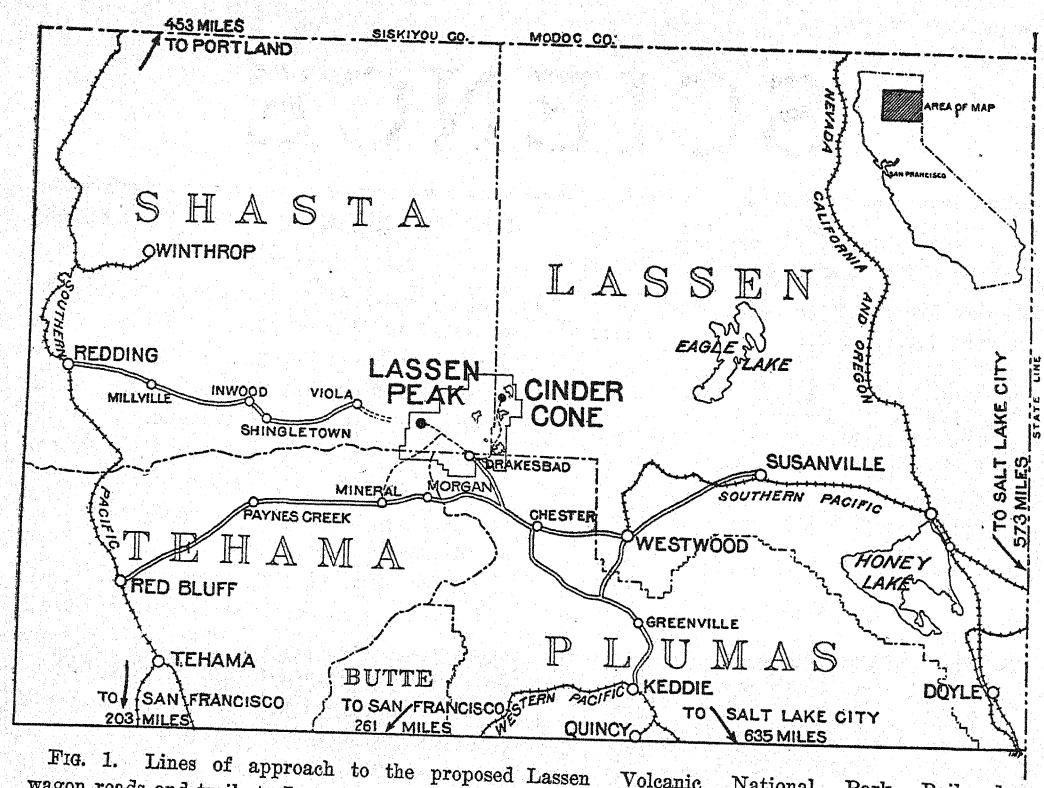

FIG. 1. Lines of approach to the proposed Lassen Volcanic National Park Railroads, wagon roads and trails to Lassen Peak and cinder cone, which are 10 miles apart and within the boundary of the proposed park.

is chiefly andesite, a viscous lava that piled up about the vents from which it issued and built up a range, the Cascade range, surmounted by great peaks, from Lassen Peak, which rises 10,460 feet, to Shasta and Rainier, that attain an elevation of more than 14,000 feet.

In the volcanic belt of the Alaskan Coast there are a number of vigorously active volcanoes. So also in Central America and Mexico, but in the Cascade range the volcanoes appear to be near extinction.

Since the white man settled on our Pacific coast there has been but little volcanic activity. In 1843, about the time Fremont, the pathfinder, made his memorable trip across the continent, Mount Baker and Mount St. Helens in the state of Washington were both in eruption, spreading a blanket of volcanic dust over the country as far south as the Columbia, where at the Dallas a missionary gave a sample to Fremont.

Professor Davidson, of the United States Coast Survey, in 1854 saw an eruption of Mount Baker. The summit was obscured by vast rolling masses of dense smoke, which in a few moments reached an estimated height of two thousand feet above the summit and soon enveloped it entirely. In 1858 Mr. J. S. Hittell saw the clouds over Mount Baker brilliantly illuminated by an eruption then taking place.[2]

Mount Rainier and Mount Shasta emit heated vapors from the fumaroles on their summits, giving evidence that their interiors are still hot.

[2] "The United States," J. D. Whitney, p. 115.

The present activity of Lassen Peak, though feeble as compared with its earlier eruptions, is proof that it must still be classed as an active volcano.

The volcanic activity which resulted in the upbuilding of Lassen Peak began near the close of the Eocene. The lava flows appear to have been largest and most numerous in the Miocene and Pliocene, successive flows decreasing in size during the Quaternary to near extinction in recent times.

There were long periods of interrupted activity separated by long intervals of quiescence. During the active periods both explosive and effusive eruptions were common; the one forming cinder cones and sheets of volcanic agglomerate and tuff; the other forming lava fields whose ruggedness was proportional to the viscosity of the erupting lava.

Lassen Peak is a volcano of large type surrounded by many smaller ones of later date, the whole being built up of a notable variety of lavas. The oldest lavas of the Lassen Peak region are of intermediate chemical composition belonging to andesites. The early magma yielding the erupting andesitic lavas in the course of time differentiated into two portions. On the one hand it became more siliceous (salic), erupting as dacite and rhyolite, and on the other hand it became less siliceous (mafic), yielding basalt and quartz basalt. All varieties are well represented in the Lassen Peak region and are derived apparently from the same magma.

As the volcanic center developed the most active crater migrated. The first crater was in the head of Mill Creek. It was not only the oldest, but also the largest crater, more than a mile in diameter. Composed of andesitic lavas, it rose to a height of 9,400 feet. The peak named "Brokeoff Mountain" on the Forest Service maps is the most prominent remnant of this great crater in the head of Mill Creek.

The second great crater opened on the northern edge of the first and erupted dacite, building up Lassen Peak to its present height with a summit crater about a quarter of a mile in diameter.

The third crater, about four miles a little west of north from the first, opened only a few centuries ago at the northwest base of Lassen Peak, and the rugged lava flows from it formed Chaos Crags.

The products of this eruption in Chaos Crags are well preserved and their relations clearly visible. The eruption began by a succession of explosions that spread a thin layer of volcanic sand and dust over the surrounding country and ended in the extravasation of a most rugged mass of dacite which, though at first glance having the aspect of granite, is rich in volcanic glass, generally of dark color, somewhat pumiceous and full of inclusions like the dacites of Lassen Peak.

The fourth crater of Lassen Peak is the new crater, active at the present time. It began by a slight explosion within the old crater, second of those enumerated, on the summit of Lassen Peak, and is remarkable for its place of outbreak, as well as its low energy, the small mass of material erupted and the continuity of the activity. Like the eruption of a few centuries ago at Chaos Crags, it had two phases, one explosive, the other effusive.

During the first phase the explosive eruptions were of gas carrying out with it rock fragments and dust only. The size of the crater increased with each eruption, as shown in Fig. 2 by the outlines of the new crater June 14, 1914, and March 23, 1915. The second phase, which is effusive, includes also an eruption of lava, which formed a lid on the volcano and overflowed to the west, as represented in Fig. 2.

In the beginning the new crater was confined to the loose material filling the old crater, but later it reached the solid rock

of the old crater rim and finally after more than 150 eruptions it attained near the end of March, 1915, a size of about 700 to 1,000 feet.

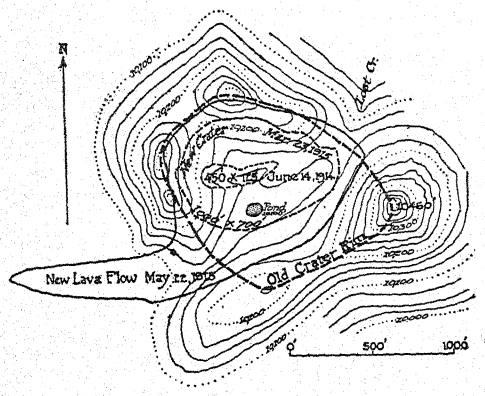

Fig. 2. Sketch contour map of the summit of Lassen Peak by J. M. Howells, June 16, 1914, upon which has been drawn the outline of the old crater rim as well as the outline within it of the enlarging new crater June 14, 1914, and March 23, 1915. The new crater at first lengthened east and west and later widened north and south, in both cases along joint planes, until its dimensions were 1,000′ × 700′. Then the explosive eruptions gradually became effusive. The lava in the throat of the volcano gradually upheaved during April and May until it filled the old crater and overflowed through the lowest notch and down the west slope about 1,000 feet. The hot blast that devastated Hat Creek escaped from beneath the lava lid at the head of Lost Creek.

Ejecta accumulated on the rim of the new crater to a depth of thirty to forty feet. The largest stone ejected was fifteen feet in diameter and weighed about sixty-three tons. Small stones were thrown as much as a mile from the crater, but beyond two miles from the crater scarcely more than a trace of dust could be noticed except to the northeast, the direction of the strongest winds and that taken by the great blast of the eruption May 22, 1915.

By far the greatest eruptions that have occurred at Lassen Peak since its present activity began are those of the night of May 19 and the afternoon of May 22, 1915. The first great result was the extrusion of new lava and the formation of a lava lid which culminated in the second great feature, the devastation of the Lost Creek and Hat Creek country by a horizontal blast of hot gas.

About the end of March, 1915, the old crater having been thoroughly cleaned out by explosive eruptions and the superincumbent load largely removed from the magma, it began to rise in the volcanic conduit and initiated the second stage, the effusive stage, of the volcanic activity. The hot magma apparently more or less viscous in the volcanic conduit, was forced upward by pressure of magma or gas from beneath and was gradually upheaved, with great escape of steam, until it reached the surface as new lava, and as a lava table filled not only the new, but also the old crater so as to form a lid on the volcano. The lava overflowing from the edge of the lid through a notch in the old rim, as shown in Fig. 2, passed down the west slope of Lassen Peak about a thousand feet.

On the night of May 19 and especially also on the afternoon of May 22, 1915, the eruptions were violent. A mushroom-shaped cloud was hurled to the height of about four miles above the summit of the mountain and afforded a magnificent spectacle as seen from the Sacramento Valley. At night[3] flashes of light from the mountain summit, flying rocket-like bodies and cloud glows over the crater reflecting the light from incandescent lavas below were seen by many observers from various points of view and appear to indicate that much of the material erupted was sufficiently hot to be luminous.

[3] Luminous phenomena were reported on the nights of September 29, 1914, May 14, 15, 17 and 19, 1915, as well as June 20 and October 20 of the same year. Some of the phenomena reported may be explained as due to the reflected rays of the setting sun, but this can not be true of all.

Professor R. S. Holway, who was one of the first observers to ascend the mountain after the eruption, saw it on May 27, five days after the eruption, and states that "hissing steam was escaping from many cracks and crevices and the shimmering air above all telling of the hot rocks below."

J. M. Howell's party visited the summit May 30, eight days after the eruption, and Mr. Spaulding reports that

> the heat from the upheaved mass was intense. The air above it shimmered with heat waves like the desert on a boiling summer day.

That the new lava in the lid at the time of its eruption was so hot at least in spots as to be luminous appears evident and it is probable that the temperature to produce luminosity, say 600° to 1,000° C. would at the same time give to the slowly rising lava such a degree of viscosity as to enable it to adjust itself to its surroundings and overflow the crater rim.

Although the lava lid in places appears to be a mass of tumbled rock fragments yet there are large portions of it essentially continuous, as if forced up in viscous condition and broken later as a result of the cooling, flowing and subsidence of the mass within the crater. The postmaster at Manton reports that a change was noticed on the summit of the mountain for a few days previous to May 19. A black wedge-shaped mass of lava appeared in the middle of the new crater, getting higher every day, and finally in plain view spilling over through the notch on the west slope.

Many volcanic bombs were ejected by explosive eruptions during the effusion of the new lava. They range up to five feet or more in diameter and are most abundant at the foot of the steeper portion of the northwest slope. Many of them have a peculiar compact crust with a cracked surface like bread crust, suggesting the name "bread crust bombs," and they are regarded as the luminous ejecta seen in connection with several eruptions by observers from different points of view. No other portion of the erupted magma afforded such impressive evidence of fusion as the bread-crusted bombs.

Although the extrusion of the new lava and the formation of the lava lid was the main feature of the great eruptions in May, it was far surpassed in interest and wonder by the remarkable horizontal eruption of the hot blast that devastated Lost and Hat Creeks.

On the night of May 19, it appears that the body of superheated gases which accumulated beneath the lid, forcing it up, escaped from under the edge with terrific force down the deep snow-covered northeast slope of Lassen Peak toward Lost Creek and Hat Creek. The snow was instantly converted into water, and the mighty onrush of water and blast of hot gases swept everything before it for more than ten miles along Lost Creek, forming a devastated belt from a few hundred yards to a mile in width. Meadows were buried beneath finer débris and occasional large boulders broken off from the edge of the lava lid far above. Trees three feet in diameter were broken off or uprooted and the country scoured as by a mighty sand blast. The fine green leaves of the pine trees left standing along the borders of the blast were killed by the heat and turned brown. Locally, on favorable slopes, the heat was so great that the green leaves were charred. Not only those of the pine, but also those of the Manzanita, several acres of which, at a distance, had the general appearance of an area swept by a forest fire. In fact it is stated by Mr. Fred Seaborn, of the Forest Service, who was in that region a few days later, that two fires were actually kindled by the eruption.

This reminds one of the hot blast from

Mount Pelée that destroyed St. Pierre. Luckily in the Hat Creek region there were only a few summer residents. Warned by the noise of the approaching torrent, they escaped to the hills.

That no one was killed was simply a matter of good fortune on the part of the eleven enthusiasts who early visited the region to make a photographic record. Mr. B. F. Loomis, the veteran photographer of Viola, was among them.

There were two hot blast eruptions into the Hat Creek country; one on the night of May 19 and the other on the afternoon of May 22.

The Loomis party arrived on the scene about noon, May 22, and spent several hours photographing up to the head of Lost Creek, making a record of what was accomplished by the first blast. They left soon after 3 o'clock and had scarcely reached the west side of Chaos Crags when the most violent eruption occurred, sending its column of smoke to a height of more than 20,000 feet, as seen from the Sacramento Valley, and a hot blast down the slope into the Hat Creek country that would probably have killed the whole party had the eruption occurred a few hours earlier.

At the time of the great outbreak a fissure was opened running from the summit northwest about 1,000 feet down the slope toward Chaos Crags. Three vents were opened on this fissure, and the greater portion of the volcanic activity during the summer of 1915 was confined to this fissure. G. W. Olsen, who ascended Lassen Peak October 19, 1915, reported the northwest fissure quiet, but another one active a few hundred feet east of it on the northern rim of the lid.

Fumaroles have developed at a number of points on the north and west slopes of Lassen Peak within 800 feet of the summit, but all the violent eruptions have occurred at or very near the summit. No fumaroles have appeared on the south and east slopes, the direction of easiest approach, where at lower levels, 5,800 to 7,400 feet, fumaroles and solfataras are such active features at Bumpass' Hell, the Devil's Kitchen, and Tartarus or Boiling Lake. These solfataras within three miles of Lassen Peak have been active with but little change during the last fifty years. They are on the strongest side of Lassen Peak and have not been affected by the eruptions at its summit, 4,000 feet above them.

The total mass of material transferred from within the mountain to the surface by the explosive and effusive eruptions during the twenty-two months since the beginning of volcanic activity at the summit of Lassen Peak is very small as compared with the results of volcanic eruptions generally, and yet its small size and high point of activity may be important factors in discovering its cause.

In any discussion as to the cause of the recent eruptions a record of the facts as to time and energy is fundamental.

The Forest Service at Red Bluff, W. J. Rushing in charge, furnished most of the important data during the summer when the rangers were in the field, but at other times Miss Alice Dines, postmaster at Manton, and G. W. Olsen at Chester, both living in sight of the mountain, supplemented the record. The eruptions have been tabulated as to time, intensity and duration, and the tabulation has a more or less evident bearing as to the efficiency of certain causes that may affect the eruptions.

The variation as to time of day at which eruptions occur is very irregular and one time of day appears about as favorable as another for eruption. Of the 220 eruptions up to the end of January, 1916, 143 occurred in the day time, while 77 occurred at night, that is between 7 P.M. and 7 A.M.

In the day time 57 eruptions occurred between 7 and 11 A.M., 40 occurred about noon, between 11 A.M. and 3 P.M., while between 3 and 7 P.M. 46 occurred. It has been supposed that a greater supply of surface water might favor eruption. If that is true, we should expect more frequent eruptions in the late afternoon or early evening when the day's supply of water from melting snow is at its maximum. On the contrary, the mornings have most eruptions, at a time when the daily heat and water supply are near their minimum.

That the volcanic energy is not dependent upon the supply of surface water to form steam is suggested by the fact that summer and autumn, the dry season, with least water, have a greater number (94) of eruptions than (84) the wet season of winter and spring.

In order to determine whether the volcano responds to the tidal wave produced in the crust of the earth by the moon, Mr. Van Orstrand has carefully considered 190 of the best recorded eruptions and concludes that as yet the results are merely suggestive.

If we compare the number of corresponding seasonal eruptions in 1914 and 1915 the result appears significant. In the summer of 1914 there were 38 eruptions, but in 1915 only 17. In the autumn of 1914 there were 56 eruptions, while in 1915 there were only 22. Since the great eruption of May 22, 1915, when the new lava was extruded and the Hat Creek country devastated, the number of eruptions has decreased and the decadence continues, but whether or not the active period of Lassen Peak is approaching its close, although probable, may be more certainly told next summer.

With its comfortably active volcano, inviting cinder cones and lava fields, vigorously boiling hot springs, mud lakes and "mush pots" for the vulcanologist to study, and the glaciated divides and canyons for the physiographer, in a setting of lovely scenery and attractive camps, for the tourists all easily accessible, the Lassen Peak region affords one of the most alluring and instructive spots for a national park.

J. S. DILLER

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.,
April 18, 1916

THE NEED FOR MORE HORTICULTURAL RESEARCH[1]

IN order to introduce my subject I hope I may be pardoned for digressing a moment. A few years ago while spending a part of a vacation in the Sierras, I climbed from the floor of Yosemite valley to the top of Glacier Point. To those of you who have been there I need not say that this climb required several hours of very severe physical effort. In traveling a mile and a half or less, the vertical ascent amounted to three thousand feet. I was accompanied by my wife, and being mindful of her safety as well as my own, I very naturally chose each step of the climb with great care. Often a contemplated step might look safe enough but, on glancing into the depths below, I would feel the necessity for making a more careful examination of the footing before risking my weight upon it. There were numerous instances when a false step might have sent us both hurtling downward, and it really is not pleasant to contemplate a half-mile drop into space even when accompanied by good company. Sometimes what appeared to be firm soil on a ledge turned out to be sand, or what looked like solid rock proved to be loose stones concealed by moss and lichens. Thus the journey was made without mishap, but slowly, tediously, because

[1] President's address delivered before the twelfth annual meeting of the Society for Horticultural Science, Columbus, Ohio, December 28, 1915.

every step had to be proved before the next one could be made.

Now this little experience in mountain climbing is not unlike that of a man who undertakes to write a bulletin, scientific paper or even to prepare a lecture to deliver in the classroom. Every member of this society has to do some or all of these things every year. And I ask you how often you have tried to make the points of your discussion safe and unassailable by proving every step you took. Take almost any subject in horticulture, no matter how commonplace, and how far can you proceed with your task if you try to make all of your statements square with proven facts? Don't you find that every few steps you discover, upon close examination, that what looks to be firm ground turns out to be loose sand and rolling stones? Facts are usually things that have been experimentally proven. Many of the accepted facts of horticulture—statements that are repeated over and over because others have used them, until they have found their way into respectable literature—too often turn out, when subjected to the acid test of careful inquiry, to be mere theories or opinions.

Granting that many of the things we give our students every day as facts are really truths that have been learned by long experience or general observation, I ask if it is not high time that we cultivate the habit of proving our statements by submitting the evidence. But, you object, we would never be able to get anywhere in a discussion—that it is out of the question to try to prove everything we say. And unfortunately this is too true, which brings me to the real subject of my remarks, viz., the great, I might almost say, the crying need, for more horticultural research.

I am using the word research here in a very broad sense, so that it may include all kinds of experimental work. Correctly speaking, an experiment is an act or operation designed to discover, test or illustrate some truth, particularly by arranging the elements or essential features of some object or process so as to permit of controlled observation, as variety tests of fruits and vegetables, pruning tests of trees or fertilizer tests with growing plants. Research, on the other hand, is diligent, protracted investigation for the purpose of adding to human knowledge. The ultimate aim of real research is the discovery of natural laws and fundamental truths. Research may, and probably will, include many experimental tests, but the aims of an investigator should reach much farther than the bare results of any tests. The experiments may be regarded as mere steps in an investigation. There appears to be a widespread belief that research means something impractical, that it can seldom or never be engaged in with direct profit to a state. Even some station directors—though happily they are in the minority—seem to hold this view.

I do not for a moment underestimate the value of experimental work. Every horticultural department should have as many experimental projects as can be handled. In this way many theories can be tested and a very great many practical questions answered. Still, some dangers may lie concealed along the experimental way, for in the very nature of things there are questions and problems that can not be answered or solved by experimentation alone. Perhaps the chief danger is the predilection for drawing unwarranted conclusions from simple tests. Also students and very young station men may be misled into believing that they are investigating when they are only experimenting, and this may be fatal to their potential future usefulness.

I can not refrain from prolonging this part of the discussion by saying that investigational work may be the most practical kind of activity that men may engage in. To cite a field of inquiry in which I may claim more or less acquaintance, I may say that the problem of the rest period of plants—while an investigation seeming on its face to serve no practical purpose, has already been found to shed light on the very live and very practical question of hardiness of fruits in cold climates. And in warm climates, particularly under semi-arid conditions, I am convinced that it will eventually serve as a foundation stone on which to establish irrigation and pruning practises as applied to deciduous fruit trees. Both pomological and irrigation divisions are now carrying on experiments, independently and cooperatively, to determine these things, but I greatly fear that all present efforts are only scratching the surface of the one great question of orchard fruitfulness.

But I have wandered away from my subject as I had meant to discuss it. What I started out to say was that we need more facts pertaining to horticultural questions. Not only should more problems be investigated in an experimental way, but whenever a piece of work is carried out, no matter how small it may be, should we not bend every energy toward establishing each and every step so securely that all will endure the wear and tear of the multitude of other workers who may desire to climb toward other things over the secure stones that we have laid? Let us not despise experiments with commonplace things just because others have been content to pass them by on the strength of current statements (unsupported by experimental proof of any kind) which say that it is best—yea even vitally necessary—to do thus and so, if certain results are to be attained.

I wish I had time to submit a full list of the common things teachers of horticulture have to discuss without being able to offer evidence that would pass muster in a justice's court. However, I shall have to be content with a few random shots that occur to me on the spur of the moment: In graftage what is meant by an uncongenial stock or lack of affinity between scion and stock? What happens when a bud with its adhering piece of bark is inserted beneath the bark of a stock? Does each part possess a complete cambium layer or each only half a layer? In healing wounds how are two outer bark surfaces, upon meeting, enabled to grow together? What relation does callusing bear to root formation in cuttings? Where can we find some reliable quantitative comparisons of tops and root systems of fruit trees? How does branch pruning affect the root system of trees? Is there a corresponding root for each vigorous new water sprout? What do we really know about the secret of fruitfulness in trees, particularly the fruiting habit? Why do so many apple trees bear on alternate years? Why can not Ben Davis and Baldwin, for example, be made to bear annually? Why is it an apple tree may bear fruit buds enough for a "full" bloom and only ten per cent. really open in spring? What is the true effect of sunlight on fruit bud formation? What are the causes of growth periodicity in trees and the relation of same, if any, to fruit-bud formation? What is "hardiness" in trees and buds? What is the nature and cause of coloring in apples? What do we know about the value of selecting buds in deciduous trees? Is "pedigree" in trees a humbug? Why do certain individual trees appear to have a superior record for fruitfulness? What is meant by vigor in trees? What is the true cause of "June drop" in fruit trees? And so on and so on; all of which makes us painfully

aware of the fact that there are a world of things appertaining to common practises which we know little about. But this lack of knowledge should not discourage us, as was the case of the fond parent in the story who put his son through a seven years' medical college course and then was thoroughly disgusted because the young man couldn't tell him how to cure a wart.

On the other hand, we should be stimulated to greater effort in seeking out facts for ourselves and we should not ignore too many of the little things just because they may seem commonplace. If a young man wants a problem he need not look far to find one. But let us get away from stereotyped statements and try to acquire a new stock of first-hand information.

Somehow or other our horticultural literature has gradually become permeated with dogmatic statements and unsupported opinions which our students are permitted to absorb as gospel truths. Who is to blame for this I can not say and I fear it would not be profitable to try to place the blame. Conditions are probably responsible for the most part in bringing about this state of affairs. For horticulture is one of the oldest of the agricultural groups recognized by the colleges and stations. Without any experimental facts at their disposal and with few or no facilities for securing experimental information, men were called upon to give instruction in fruit-growing and gardening and they met the situation as best they could by drawing upon their own practical experience or the experience of horticultural friends and did their best to explain why certain things had to be done so and so, even though it sometimes became necessary to draw heavily upon their imagination. But, in the language of the day, they "got away with it" and some of us have continued, more or less, to keep up the practise.

Reform, however, is coming about and coming from a source least expected, viz., from the students that we have to teach. With the rapid raising of standards for entrance in the agricultural colleges, came a class of students with good fundamental training who refused to accept the time-honored statements so general in horticulture without at least plausible explanations. I feel certain that this has been the chief force that has broken the old traditions and is bringing about a brand-new horticulture. I am sure a brighter day is dawning and that we shall soon be free from all the hampering fetters of the past.

One reason for my cheerfulness regarding the horticultural situation is the result of an inquiry which I recently addressed to all the experiment stations in the United States. Since there is somewhat of a scarcity of reliable horticultural literature along many lines, I greatly feared that administrative officials might be placing better facilities at the disposal of their departments of chemistry, botany, etc., but I find that apparently such is not the case. My findings show that approximately half of the stations of the United States have one or more officials in horticulture designated as research men, but that eighteen per cent. of these persons do some teaching. However, I did not learn the nature of this teaching. If it is a limited amount of graduate or upper class instruction the men will be all the better investigators, but with too much lower class work their research titles may become a farce. Station directors often reported men as doing no teaching while the men themselves said that under stress of circumstances they were compelled to do a considerable amount of teaching. Deans and directors are sometimes great "boosters." From incomplete replies representing thirty or thirty-five institutions, it appears that horticulture is fully as well represented by

research men as other departments of the stations.

An effort was made to find if the output of horticultural bulletins is as great as from other departments, but this part of the inquiry was a failure. Of the nearly 200 "official" horticultural projects now under way in the various stations, about eleven per cent. are Adams Fund investigations and over thirty per cent. of the others are regarded as being of research grade.

In conclusion I may add that it appears that the whole range of horticulture from floriculture to pomology now seems to be as well manned as other departments, and if the next few years does not see a greatly increased output of reliable literature, then we are not living up to our opportunities.

W. L. HOWARD

UNIVERSITY FARM,
DAVIS, CAL.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE TREASUREE, 1914

IN compliance with Article 15 of the Constitution, and by direction of the Council, I have the honor to submit the following report, showing receipts, disbursements and disposition of funds of the association for the year ending December 31, 1914.

Receipts have come into the keeping of the treasurer from one source, namely, interest on funds deposited in savings banks. The total amount of this interest is $935.49.

Disbursements made in accordance with the direction of the council amount in the aggregate to $448.67.

The total amount of funds of the association deposited in banks and subject to the order of the treasurer December 31, 1914, is $30,138.20.

The details of receipts, disbursements and disposition of funds are shown in the following itemized statement.

R. S. WOODWARD,
Treasurer

April 1, 1914

The Treasurer in Account with the American Association for the Advancement of Science

DR.

1914		
Jan. 1.		
To balance from last account		$29,651.38
To interest on funds in banks as follows:		
Cambridge Savings Bank, Cambridge, Mass.	$46.41	
Emigrant Industrial Savings Bank, New York, N. Y.	120.00	
Metropolitan Savings Bank, New York, N. Y.	105.00	
Union Square Savings Bank, New York, N. Y.	105.00	
U. S. Trust Co., New York, N. Y.	499.68	
Munsey Trust Co., Washington, D. C.	59.40	935.49
Total		$30,586.87

CR.

1914.		
Dec. 3.		
By interest paid on 252 life memberships		$398.67
Dec. 4.		
By one life membership under Jane M. Smith Fund		50.00
By cash in banks as follows:		
Cambridge Savings Bank, Cambridge, Mass.	$1,066.81	
Emigrant Industrial Savings Bank, New York, N. Y.	3,120.00	
Metropolitan Savings Bank, New York, N. Y.	3,105.00	
Union Square Savings Bank, New York, N. Y.	3,105.00	
U. S. Trust Co., New York, N. Y.	19,613.78	
Fifth Avenue Bank of New York, N. Y.	127.61	30,138.20
Total		$30.586.87

I hereby certify that the foregoing account is correctly cast and properly vouched.

HERBERT A. GILL,
Auditor

1915

In compliance with Article 15 of the constitution, and by direction of the council, I have the honor to submit the following report showing receipts, disbursements and disposition of funds of the association for the year ending December 31, 1915.

Receipts have come into the keeping of the treasurer from two sources, namely, from life membership commutations and from interest on invested funds. The total amount of these receipts is $1,403.14.

Disbursements made in accordance with the direction of the council amount to an aggregate of $900.

The total amount of funds of the association deposited in banks and subject to the order of the treasurer December 31, 1915, is $30,641.34.

The details of receipts, disbursements and disposition of funds are shown in the following itemized statement.

R. S. Woodward,
Treasurer

April 1, 1915

The Treasurer in Account with the American Association for the Advancement of Science

DR.

1915.		
Jan. 1.		
To balance from last account		$30,138.20
Jan. 27.		
To 10 life memberships		530.00
Dec. 31.		
To interest received on funds in banks as follows:		
Cambridge Savings Bank, Cambridge, Mass.	$45.81	
Emigrant Industrial Savings Bank, New York, N. Y.	120.00	
Metropolitan Savings Bank, New York, N. Y.	120.00	
Union Square Savings Bank, New York, N. Y.	105.00	
U. S. Trust Co., New York, N. Y.	482.33	873.14
Total		$31,541.34

CR.

1915.		
Jan. 19.		
By grant paid Alfred Dachnowski		$150.00
By grant paid Concilium Bibliographicum		400.00
April 10.		
By 2 life memberships under Jane M. Smith fund		100.00
May 4.		
By grant paid Lyman Briggs		250.00
Dec. 31.		
By cash in banks as follows:		
Cambridge Savings Bank, Cambridge, Mass.	$1,112.62	
Emigrant Industrial Savings Bank, New York, N. Y.	3,120.00	
Metropolitan Savings Bank, New York, N. Y.	3,120.00	
Union Square Savings Bank, New York, N. Y.	3,105.00	
U. S. Trust Co., New York, N. Y.	19,296.11	
Fifth Avenue Bank of New York, N. Y.	887.61	30,641.34
Total		$31,541.34

I hereby certify that the foregoing account is correctly cast and properly vouched.

Herbert A. Gill,
Auditor

REPORT OF THE SECRETARY

L. O. Howard, Permanent Secretary, in Account with the American Association for the Advancement of Science from November 1, 1914 to October 31, 1915

DR.

To balance from last account		$7,095.74
To receipts from members:		
Annual dues, 1915	$22,184.00	
Annual dues, 1916	100.00	
Annual dues, previous year.	372.00	
Admission fees	2,305.00	
Associate membership fees.	24.00	
Life membership fees	570.00	25,555.00
To other receipts:		
Sale of publications	19.20	
Treasurer's payment towards subscriptions to Science for life members	398.67	
Bequest from R. T. Colburn estate	750.00	
Miscellaneous receipts, including postage, sale of programs, and interest..	348.85	1,516.72
		$34,167.46

The foregoing account has been examined and found correct, the expenditures being supported by proper vouchers. The balance of $4,616.04 is with the following Washington, D. C., banks:

American National Bank of Washington.	$459.76
American Security and Trust Co.	4,156.28
	$4,616.04

Herbert A. Gill,
Auditor

Washington, D. C.,
April 1, 1916

By publications:		
Publishers Science	$15,630.35	
Volume 63–66, preliminary announcement, circulars and forms	4,393.90	$20,024.25
By expenses Philadelphia meeting:		
To secretaries of Sections, general secretary and secretary of council	901.50	
To badges, help and general expenses	308.06	1,209.56
By expenses of Pacific Division:		
To salary of assistant secretary	1,050.00	
To allowance for office expenses	600.00	
To allowance for extension of membership	550.00	2,200.00

By expenses of Washington office:		
To salary of permanent secretary	1,500.00	
To salary of assistant secretary	1,500.00	
To extra help	1,100.23	
To postage	1,308.00	
To office supplies	112.77	
To expressage, telephone and telegrams	47.81	5,568.81
By miscellaneous disbursements:		
To treasurer, life membership commutations	530.00	
To committee of One Hundred on Scientific Research	18.80	548.80
		$29,551.42
By balance to new account		$4,616.04
		$34,167.46

SCIENTIFIC NOTES AND NEWS

THE late Lady Kelvin has bequeathed to Glasgow University £5,000 for promoting research and the teaching of physical science in connection with the chair of natural philosophy, long held by Lord Kelvin. The decorations and medals conferred on Lord Kelvin are also given to the university.

THE British Chemical Society has decided to publish portraits of the three past presidents, Sir Henry Roscoe, Dr. Hugo Müller and Professor Raphael Meldola, who have died during the past year. The portraits will be suitable for framing or for binding with the *Journal*.

THE Paris Academy of Sciences has elected as corresponding members Professors Liapounof, of Petrograd, and C. J. de la Valleé Poussin, of Louvain.

THE Paris Academy of Medicine has elected as foreign associates Professor Hector Treub, of Amsterdam, and Sir Almroth Wright, of London.

DR. WILHELM BRANCA, professor of geology at Berlin, has been elected a member of the Academy of Sciences at Halle.

DR. GEORGE W. CRILE, professor of surgery at the Western Reserve University, received the honorary degree of doctor of letters from Wooster College on May 12.

DR. CHAS. G. WAGNER, superintendent of the State Hospital for the Insane at Binghamton, New York, was elected president of the American Medico-Psychological Association at the recent New Orleans meeting.

HAROLD WINTHROP BUCK, vice-president of the engineering firm of Viele, Blackwell & Buck, of New York City, has been elected president of the American Institute of Electrical Engineers.

SIR THOMAS H. HOLLAND, F.R.S., professor of geology in the University of Manchester, has been appointed chairman of a commission which the British government is forming to survey the economic resources and industrial possibilities of India.

DR. H. S. HALLOWAY, Boston, has been appointed state bacteriologist of Alabama.

W. F. HORTON, mining technologist of the bureau of mines, has resigned to accept a position with a steel company.

FREDERICK J. H. MERRILL, from 1899 until 1904 state geologist of New York, from 1905 until 1913 consulting geologist and mining engineer in Mexico, Arizona and California, and since 1913 field assistant of the California State Mining Bureau, has moved to Los Angeles, where he will resume consulting practise in geology and mining engineering.

J. D. THOMPSON, JR., assistant in geology at Cornell University, has accepted a position as geologist with an oil company in Oklahoma.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist of the U. S. Department of Agriculture, will leave about May 28 for Honolulu to study and collect the grasses of the Hawaiian Islands. He will be accompanied by his son, Albert E. Hitchcock, as assistant.

MR. ARTHUR W. SAMPSON was at the New York College of Forestry, from May 10 to 12 inclusive, holding seminars and lecturing upon grazing in the national forests. Mr. Sampson is plant ecologist in the Forest Service and director of the Utah Forest Experiment Station in central Utah.

AT a meeting of the Washington Academy of Sciences on May 11, Dr. Erwin F. Smith, of the Bureau of Plant Industry, delivered an illustrated address on "Resemblances between Crown Gall in Plants and Human Cancer."

A PUBLIC meeting of the District of Columbia Chapter of the Society of the Sigma Xi was held in the auditorium of the U. S. National Museum, on May 19, 1916. Mr. Frank N. Meyer, agricultural explorer for the U. S. Department of Agriculture, gave an illustrated lecture entitled "Travel and Exploration in China." About two hundred members and guests of the chapter were present. This was the first public lecture that has been given by the recently organized alumni chapter in Washington, D. C.

AT the meeting of the New York Academy of Medicine, on May 4, Dr. Walter B. Cannon, George Higginson professor of physiology in the Harvard Medical School, delivered an address on "An Explanation of some Disorders supposed to have an Emotional Origin." The discussion was opened by Dr. Henry Rutgers Marshall.

PROFESSOR FREDERIC SLOCUM, of the department of astronomy of Wesleyan University, gave an address, on May 19, before the Brown Chapter of Sigma Xi at Brown University on "The Structure of the Sidereal Universe."

AN appeal was made to the medical fraternity of Philadelphia at the College of Physicians, on May 5, to supply at once fifty physicians and surgeons for service in China. The appeal was made by Professor W. H. Welch, of the Johns Hopkins University, a member of the Chinese Medical Board and Dr. H. J. Howard, connected with the Canton, China, Hospital.

AT the meeting of the Chemical Society, held at Burlington House on May 18, the last of the three lectures arranged for this session was delivered by Professor F. Gowland Hopkins, F.R.S., whose subject was: "Newer Standpoints in the Chemical Study of Nutrition."

THE annual meeting of the British Iron and Steel Institute was held at the Institution of Civil Engineers on May 4 and 5. An inaugural address was delivered by the new president, Sir William Beardmore, and the Bessemer medal for 1916 was presented to Mr. F. W. Harbord.

IN memory of the late Professor Charles Simeon Denison, whose death occurred three years ago, a bronze tablet has been placed in the arch of the engineering building of the University of Michigan, and the arch has been named the Denison Archway. Professor Denison was for forty-two years a member of the engineering faculty, and was the first to foster the idea of the construction of the Engineering Arch.

ELMER LAWRENCE CORTHELL, distinguished as a civil engineer, died at Albany on May 16, aged seventy-six years.

THE twenty-first summer meeting and eighth colloquium of the American Mathematical Society will be held at Harvard University during the week beginning Monday, September 4, 1916. The first two days will be devoted to the regular sessions for the presentation of papers. The colloquium will open on Wednesday morning and close on Saturday morning. Courses of five lectures will be given by Professor G. C. Evans on "Topics from the Theory and Applications of Functionals, Including Integral Equations," and by Professor Oswald Veblen on "Analysis Situs."

THE Secretary of State, on the recommendation of the superintendent of the United States Coast and Geodetic Survey, and the Secretary of Commerce, has recently appointed Mr. William Bowie, of the Coast and Geodetic Survey as the member from the United States of the Permanent Commission of the International Geodetic Association. Since 1909 Mr. Bowie has been chief of the Division of Geodesy of the United States Coast and Geodetic Survey, and in 1912 he was one of the delegates from the United States to the convention of the International Geodetic Association, which met in Hamburg, Germany. This association was organized more than fifty years ago for the purpose of securing the cooperation of the European nations in undertaking certain geodetic problems which were international in scope. In 1886 the association invited nations outside of Europe to join and three years later Congress gave the United States permission to become a contributing member. Previous to the present war twenty-

three nations of the world were represented in the association. One of the most important of the recent undertakings of the association is the maintenance of four observatories for the study of the variation of latitude. These observatories are located on the thirty-ninth parallel of latitude, in the United States, Italy, Turkestan and Japan. Ukiah, California, is the location of the observatory in this country.

THE *Bulletin* of the American Mathematical Society notes that on account of the war two mathematical periodicals have suspended publication, *L'Education Mathématique,* which concluded its sixteenth and last volume with the issue for July, 1914, and the *Revue de Mathématiques Spéciales,* last issued in September, 1914, in completion of its twenty-fourth consecutive year.

AT the eighty-seventh annual general meeting of the Zoological Society of London, according to the report in the London *Times,* the Duke of Bedford, who presided, said that during 1915 they had repaid the bankers £5,000 instead of the usual £2,000 and had invested over £4,000, chiefly in war loan. Thus in a full year of war they had improved the financial position of the society by £9,000. They had stopped all new work; they had postponed improvements in the gardens; they had refrained from making costly purchases; and they had greatly reduced expenditure on the library and scientific publications. But despite increased cost of provisions they had not allowed the animals to suffer in condition. The council had decided to keep up the flower gardens, believing that the bright presentment of the return of spring and promise of sunny summer days are legitimate distractions at this time. That the gardens had proved attractive in the past year was proved by the fact that for the fourth year in succession the number of visitors had been over a million. During the war the families of sailors and soldiers on active service were admitted free and on Sundays wounded men in uniform were also admitted free.

THE third meeting, for the year 1915–16, of the Pennsylvania Chapter of Sigma Xi was held in the Wistar Institute of Anatomy on Wednesday evening, March 29, 1916. Supper was served in one of the large laboratories on the third floor of the institute to ninety-five members. Afterwards Dr. Greenman presided and Dr. Allen J. Smith spoke on "Leprosy" in the Library on the second floor. Under the title of the "Rat in the Service of Biology," Dr. H. H. Donaldson reviewed the neurological investigations at the Wistar Institute for the last ten years, describing some of the advantages offered by the albino rat for biological studies. The members were then conducted on a tour of inspection of the institute. Special interest was manifested in the colony house, containing 5,000 rats, used in the experimental work.

THE Berlin Society of Social Hygiene, shortly after the beginning of the war, postponed indefinitely the awarding of the prizes ($200 and $100) for the best essays on "Influence of Social Betterment of Families on Eugenics." The society has decided to award the prizes on July 31, 1916.

ON Tuesday evening, April 11, Northwestern University celebrated the fiftieth anniversary of the founding of Dearborn Observatory. The observatory was founded by the citizens of Chicago in December, 1862, and within a month of the inception, the world's then greatest telescopic lens was purchased. In November, 1865, the group of contributors perfected the organization of the Chicago Astronomical Society, and on December 28 called Professor Truman H. Safford to the directorship. On his arrival the telescope was shipped, reaching Chicago on March 25; it was in place on April 11, 1866. On that evening the members of the society and guests assembled to make the first observation. Under Professor Safford's direction the work of the observatory went forward actively until the Great Chicago Fire of 1871 prostrated the city and robbed the observatory of its support. Professor Elias Colbert, who had been assistant director, later assumed active charge, and with the exception of a few months in 1876, when Professor S. W. Burnham was acting director, remained in charge until the appointment of Professor George W. Hough to the directorship on May

6, 1879. On August 10, 1887, a contract between the society and Northwestern University was made, and shortly thereafter the instruments were transferred to Evanston and placed in the observatory built through the gift of Mr. James B. Hobbs. Professor Hough actively conducted the observing until his death on January 1, 1909. The present director, Professor Philip Fox, was appointed September 1, 1909.

Professor E. J. Saunders, of the department of geology of the University of Washington, will conduct a geological field course in the Glacier and Yellowstone Parks from June 19 to July 28.

The plans for the coming season of the Harvard Field School of Physiography and General Geology provide for eight weeks of continuous field work in an unsurveyed portion of the Rocky Mountains. Camp will be established on the south slope of the San Juan Mountains of southwestern Colorado. Work will begin early in July and continue until the second of September. There will be accommodations for twenty-four students in the party. Two distinct units will be organized. Professor Wallace W. Atwood will have general charge of the work. Dr. W. P. Haynes will have immediate direction of the work of one unit, and Dr. F. H. Lahee of the other unit. During the first six weeks a systematic geological and geographical survey will be made of a portion of the range. This work will be conducted as nearly as possible along the lines approved by the U. S. Geological Survey. During the last two weeks the party will take a somewhat extended tour through the higher mountains, so as to study a wide range of phenomena, visit several of the mines and mills, and come to appreciate the larger problems in the geologic and physiographic history of the mountain area. Those wishing to join the party should apply to the director as soon as possible. Membership will probably be closed by the first of June.

The Naples Table Association for Promoting Laboratory Research by Women has held its annual meeting at Bryn Mawr College. It was voted to offer a prize of $1,000 for award in April, 1918, for the best thesis written by an American woman on a scientific subject embodying new observations and new conclusions based on independent laboratory research in biological (including psychological), chemical or physical science. Miss Virginia Gildersleeve, dean of Barnard College, was elected president for 1916–17; Mrs. Elizabeth L. Clarke, representing Smith College, treasurer; Mrs. Ada Wing Mead, of Providence, secretary for three years.

The estate of Addison Brown, for many years a United States District Judge, who died on April 9, 1913, has been appraised at $883,406. Judge Brown, who was an authority on the flora of the United States, left United States Steel stock valued at $21,775 to the New York Botanical Gardens for publications. He gave $10,000 to Harvard, of which $7,500 was to establish a scholarship for an undergraduate student, and $2,500 for a prize in the law school for an essay on maritime or private international law. Amherst College and Bradford Academy each received $5,000 for scholarships.

UNIVERSITY AND EDUCATIONAL NEWS

The fiftieth anniversary of the founding of Carleton College will be celebrated on October 12 and 13.

The curriculum of the college of mining of the University of California has been reshaped so that with the beginning of the sophomore year students will choose between mining engineering, metallurgy, economic geology, or petroleum engineering. A new four-year course in chemical engineering has been announced by the college of chemistry, of which Gilbert N. Lewis is the dean.

Col. John Biddle, engineer officer, U. S. A., at Baltimore, has been appointed superintendent at West Point to succeed Col. Clarence P. Townsend on July 1.

Mrs. Aurelia Henry Reinhardt has been elected president of Mills College, California.

At the New Mexico College and Station, Dr. E. P. Humbert has resigned as dean of agriculture and agronomist to become plant

breeder in cotton investigations at the Texas Station, and has been succeeded by Rupert L. Stewart.

DR. F. J. E. WOODBRIDGE, Johnsonian professor of philosophy in Columbia University and dean of the graduate faculties, has been appointed lecturer in philosophy on the Mills Foundation in the University of California, from January 31 to June 30, 1917.

DR. WILLIAM F. ALLEN, instructor in anatomy, University of Minnesota, has accepted a position as professor of anatomy in the medical department of the University of Oregon.

DR. ALFRED L. GRAY, professor of physiology in the University of Virginia, has been transferred to the chair of roentgenology and has been succeeded by Dr. Charles H. Lewis.

PROFESSOR W. H. TWENHOFEL, of the University of Kansas, has been appointed associate professor of geology at the University of Wisconsin, to succeed Professor Eliot Blackwelder.

FRANK H. PROBERT, a graduate of the Royal School of Mines, London, and for the past twenty years engaged in consulting mining engineering practise, has been appointed professor of mining in the University of California, as successor to the late Professor Samuel Benedict Christy.

DR. JEAN FELIX PICCARD, of the University of Lausanne, Switzerland, has accepted an invitation of the University of Chicago to spend next year at the university as assistant professor of organic chemistry. Dr. Piccard, who has worked with Professor Willstaetter and been research assistant of Professor v. Baeyer, will devote himself exclusively to graduate work and to directing research in organic chemistry.

DISCUSSION AND CORRESPONDENCE

CONSERVATIO VIRIUM VIVARUM

TO THE EDITOR OF SCIENCE: The term energy was introduced by Thomas Young in 1807 to denote MV^2, or twice what is now known as kinetic energy. Rankine extended its use to cover potential and total energy. But though the name was new the concept was not. This was known long before under the term facultas agendi, which is in some respects more appropriate, for if our word energy is to be translated into Greek it must be rendered δύναμις not ενέργεια.

The following extract from an old paper contains a part of the early history of the idea of energy.[1]

There seems to be a general impression that the natural philosophers of the last century, when they used the quantities now known as kinetic, potential and total energy at all, regarded them from a purely algebraical or geometrical point of view, failing to perceive their great physical significance. In this respect these physicists seem to have been underrated: as some passages from the first John Bernoulli, Euler's teacher and D. Bernoulli's father, will show. In a paper on the true conception of living forces[2] he generalizes the idea of vis viva and defines it as equivalent to capacity for doing work, or *facultas agendi*, which is simply a Latin equivalent of the Greek energy [as Young understood it]. In Section I. of this paper he says (translated):

> Vis viva does not consist in the actual exertion, but in the capacity for doing work; for it subsists even when it does no work nor has any object whereon it could act; so for example a strained spring, or again a body in motion, has in itself the capacity of doing work, so that if nothing external to itself comes in its way upon which it may exert itself, and so long as there is no object present with which it can come in contact, it infallibly retains it all undiminished by time, and does not do the work which it would be capable of doing if it had the opportunity.

This seems a clear and even a vivid statement of the law:

> When a system is subjected to no external forces, its energy remains constant.

In Section III. he takes a further step.

> Vis viva (which would be more aptly named facultas agendi, gallicé le pouvoir)[3] is something real

[1] *Amer. Jour. Sci.*, Vol. 45, 1893, p. 97. See also *idem.*, Vol. 46, 1893, p. 151.

[2] "De vera notione virium vivarum," *Acta Eruditorium*, Leipzig, 1735, p. 210.

[3] The term power is now rarely used for energy, but it is scarcely a generation since this meaning was common enough. Saint-Venant (*op. cit.*, p.

and substantial, which has an independent existence and, whatever it consists of, depends upon nothing else. Whence we conclude, that any given vis viva is of determinate quantity of which none can disappear except it reappear in the effect produced. Hence it follows at once, that vis viva is always preserved, and so perfectly that what inhered in one or many bodies before action is now, after action, necessarily found in another or in several others excepting what remained in the first system. And this we call the *conservationem* virium vivarum.

Compare this with the modern statement: In any system the variation of energy is equal to the external work done by the system less the work done by external forces upon the system.

John Bernoulli was under no misapprehension as to the importance of the principles he had stated. He says in substance: Whether bodies are regarded as communicating motion to one another or whether one considers the various modifications of the motion of one and the same body depending on its own force (where nothing can vanish without an equivalent effect), "pro fundamento et principio universali poni debet conservatio virium vivarum, hoc est illius *facultatis agendi*."

George F. Becker

SERPENT DREAD IN THE PRIMATE FAMILY

Apropos of the discussion which has been appearing in Science relative to fear of snakes, I am impelled to observe how unfamiliar some writers on an evolutionary topic appear to be with what Darwin, himself, the fountain head of evolution, may have had to say on the subject.

Darwin, in his "Descent of Man," second edition, Appleton, 1892, page 72, calls attention to this primal instinct in man and monkeys, and gives an account of how his experiments with monkeys in the zoological gardens confirmed the previous experiments of Brehm, in establishing its presence in the whole primate family.

While not agreeing with Mr. Dabney in his conclusions that India is pointed to as the place where a snake-fearing creature would most likely originate because of the abundance of poisonous snakes there (serpents of the constrictor class would be even more of a menace to those "long tailed, pointed eared ancestors" of ours if Huxley's further deduction be accepted that "they were probably arboreal in their habits"), it seems to me that the evidence is overwhelming in favor of "serpent dread" being a vestigial instinct—exceptions to its presence in persons like Mr. McClellan to the contrary notwithstanding.

In my own case, though for years a teacher of zoology, and accustomed to the handling of snakes, I confess to never having been able to entirely overcome a certain shuddering dread of them, and am convinced that my repugnance is not due to early teaching on the subject. I am sure that this is the normal attitude of the members of the human family, and the rest of the primates as well, toward snakes.

That very young children may not have as yet developed in them this fear is no argument against its being an inherited instinct.

There are many such instincts that do not appear until the period in life when the exercise of them would operate most strongly for the protection of the species.

It is a well-known fact that the young of the primates are quite helpless for a relatively long period, and during this stage of their existence are carried about and cared for exclusively by the mother. There would ordinarily be no protective service performed by the exercise of "serpent dread" in the young during this period.

Nor is it a matter of much weight against the instinctive character of the fear that it is not always very discriminating zoologically. It is enough that there is some suggestive resemblance or association in the object which arouses it.

A shadow made by an old hat shied over a flock of young chickens will be just as effective in sending them scurrying to cover, as that of the hawk itself, and will evoke from the mother hen just as surely the characteristic warning cry. Also a crooked stick met with

785) in 1864 defined the potential of one or more forces as "leur pouvoir moteur total." B. Peirce in his great work on analytical mechanics, 1865, always uses "power" instead of "energy."

in the woodland path, or a rustle in the dry grass beside it, will startle a person fully as much as the sight of the snake itself seen a short time before.

As very strong evidence in favor of the universality of the serpent dread instinct is the solution it affords to the familiar serpent nature-myth in Genesis. Scholars are pretty well agreed that the true interpretation of primitive legends lies in the attempts of primitive peoples by them to explain the origin of fundamental institutions, universal customs, innate impulses.

As Gunkle in his "Legends of Genesis" observes:

> They [the legends] are attempts to answer such questions as, Whence came the heavens and the earth? Whence the language of man? Why the love of the sexes? Why does the serpent go on his belly, and why does the "seed of woman" continue so relentlessly to "bruise its head"?

Such a legend speaks eloquently of the universality in the human family of the fear and hatred of snakes, and of the instinctive character of these emotions.

ARTHUR M. MILLER

LEXINGTON, KY.

TO THE EDITOR OF SCIENCE: The disputants regarding our instinctive fear of snakes may "all be right and all be wrong." It is not necessary that the whole human race should have the same instinct. The feeling of repulsion for snakes and worms, and that for many-legged things such as spiders and centipedes, are rarely felt by the same person. I have the latter to an uncontrollable degree, and I do not believe that I learned it from any one. I can not remember that either of my parents felt about spiders as I do. I do not feel about snakes and worms in the same way at all. It is therefore possible that one person may have a congenital repulsion for snakes and that another may have been free from such a repulsion from childhood.

As for establishing a connection between such facts and "the cradle of the human race," I leave that to the mythical philologist who derived Middletown from Moses "by dropping the 'oses' and adding 'iddletown.'"

ARTHUR E. BOSTWICK

SCIENTIFIC BOOKS

Laboratory Manual for the Detection of Poisons and Powerful Drugs. By WILHELM AUTENRIETH. Translated by WILLIAM H. WARREN. Second American edition from the Fourth German edition. 8°. P. Blakiston's Son and Co., Philadelphia, 1915. Pp. xv + 320; Figs. 25. $2.00.

The fourth German edition of this well-known laboratory text-book has been sufficiently revised, enlarged and extended in scope to warrant the term "manual" as it appears upon the title page. Former editions were so incomplete in every subject covered as to lead the reader to wonder whether the title was not a misleading one.

In this last edition the author has presented his subject in the same order, chapter by chapter, as in former editions. The book being strictly a laboratory guide, the chapters dealing with the various noxious substances discussed, have naturally been arranged with reference to the sequence of steps taken by the chemist in his search for the presence of a poison.

Chapter I. treats of poisons which may be volatilized in a current of steam and thus separated from organic material. Chapter II. discusses the Stas-Otto method for the extraction of vegetable poisons and powerful drugs and describes the special reactions by which these substances may be identified. Chapter III. treats of the inorganic (metallic) poisons. Chapter IV. discusses corrosives, several poisonous anhydrides of organic acids; a number of powerful synthetic drugs; toxalbumins and matters of importance to physician and analyst. Under Chapter V. are grouped a selection of special methods for the qualitative detection and quantitative determination of arsenic, phosphorus, a number of important alkaloids, and salicylic acid. In this chapter is also given a brief outline of Mauch's very ingenious chloral hydrate method for the separation and identification of the active principles of plants. Chapter VI. is devoted to crude drug assay and evaluation according to the official methods of the German pharmacopœia. Chapter VII. discusses the forensic chemistry of blood and blood stains.

The translator has admirably performed his task and has placed in the hands of American students a book almost unique in its field in the English language. The text is exceptionally free from the peculiarities of Teutonic sentence construction usually met with in translations of German works. The additions made by Dr. Warren to the new American edition greatly enhance the usefulness of the book as a student text. It is to be regretted that in his additions to the chapter dealing with the identification of human blood he did not include the recent American advances in the study of "blood crystals" (Reichert and Brown) which to the chemist are more important than agglutination tests, and that he did not feel warranted in inserting in Chapter VI. some of the official methods of drug assay according to the U. S. Pharmacopœia. Doubtless many other teachers in common with the reviewer, using this book as a laboratory text with their students, believe that, although the primary object in work of this nature is to afford instruction in manipulation and chemical reactions, if this can be accomplished by the use of official methods it is wiser to employ such processes than those which the student may not use in his future work. It would not have added materially to the size of the book to have introduced notes pointing out the divergence of U. S. P. methods (if any) from those given by Autenrieth.

A matter of surprise is that the space devoted to poisoning by phosphorus has been increased, although statistical information leads to the conclusion that cases of phosphorus poisoning have greatly decreased since the manufacture of the yellow phosphorus match has been forbidden by statutory enactments. Obviously no small laboratory manual can be complete, yet it is a matter of disappointment that such very important drugs as the morphine derivatives such as heroin, peronin, etc., have received no mention, nor have the cocaine substitutes, eucaine, novocaine, etc. In view of the stringent American antinarcotic laws and the nation-wide campaign to stamp out habit-forming drugs, it is difficult to understand why such manifestly important matter should have been omitted by the translator.

In spite of the small size of the book, Dr. Autenrieth has succeeded in incorporating between the covers a surprising amount of information and suggestions. This has been accomplished by the free use of fine type and by making all descriptions of tests and methods as brief as possible. This attempt to carry conciseness of statement to the limit is one of the only serious faults so far as the actual material presented is concerned, for the reviewer has found that his students experience great difficulty in properly performing many of the tests described.

Taken all in all the tests selected have been well chosen and with one or two exceptions the directions given are correct and down to date. The book can be heartily recommended to all who are interested in the usual problems of forensic chemistry and should prove a welcome addition to the book shelf of every analytical chemist and pharmacist. Not the least interesting sections will be found to be those giving a brief summary of our present knowledge of the action of poisons and the changes they undergo during their elimination.

E. M. Chamot

The Chemistry of Colloids. By W. W. Taylor. London, Edward Arnold. 328 pp. 7/6 net.

This is the first attempt at an original textbook in English dealing with the important subject of colloidal chemistry. The author is a lecturer in chemistry at the University of Edinburgh, and the book owes its birth, as is the case of many scientific books, to a series of lectures given by the author before a class of advanced students. Viewed in this light, the book will undoubtedly prove useful, not only to the student, for whom it will save laborious note-taking; but also to the instructor, who will benefit by the mass of arranged facts which the book offers.

The principal portions of colloidal chemistry are treated in a manner which is not only brief but sometimes approaches laconicism. The general properties of colloids are followed with a discussion of the van Weimarn theories of amorphous substances which naturally lead to a description of the usual methods for preparing colloidal solutions. The theoretical side of

colloidal chemistry, *i. e.*, the questions of surface tension, adsorption, etc., which are of such fundamental importance to the whole subject, are first discussed toward the end of the book. In the opinion of the reviewer this is an unfortunate arrangement, for to take one example, a treatment of the coagulation of colloidal solutions without a knowledge of the adsorption laws, must necessarily be handicapped to say the least.

For the professional worker in the field of colloidal chemistry, the book has little to offer, first because of its brevity and second because of the fact that although dated January, 1915, many of the results of recent research are not to be found in the book.

However if one is interested in obtaining a statement of the principal facts of colloidal chemistry unencumbered with too much theory, the book is to be recommended.

WALTER A. PATRICK

Handbook of Colloidal Chemistry. By Wo. OSTWALD. Translated by M. H. FISCHER. 278 pp. Blakiston's Son & Co. $3.00 net.

The above book is a translation of the third German edition of Wo. Ostwald's "Grundriss der Kolloidchemie." Wo. Ostwald's name has been so intimately associated with the development of colloidal chemistry, that it needs no introduction even to American readers. His broad general knowledge of his subject reminds one very forcibly of the attitude of his father, Wilhelm Ostwald, toward physical chemistry. Following the footsteps of his father, the son also endeavored to write an authoritative text-book in his own chosen field. The above book is the result, and while the reviewer can not agree with the translator in saying that Wo. Ostwald in colloidal chemistry occupies a position analogous to Wilhelm Ostwald in physical chemistry, or J. Liebig in agricultural chemistry, nevertheless one must agree that his text-book is most stimulating and interesting.

The book is divided into two parts, a general and special study of colloidal chemistry. The first part is devoted largely to classification and systematics, being the particular field in which Ostwald excels. The treatment is very general, indeed in many cases it seems as if the spirit of generalization was carried too far. This is well illustrated in Ostwald's "negative" surface tension, the existence of which is not supported by experimental evidence and which would indeed be contradictory to our fundamental ideas of surface tension.

The second part of the book dealing with the properties of colloidal solutions is the most interesting. This is especially true of that portion which treats of the viscosity of colloidal solutions.

The book is made very attractive with its abundant photographs and tables. On the whole the translation is acceptable, but the frequent use of the ugly word "dispersion-means" in the place of dispersion medium strikes one as inexcusable.

WALTER A. PATRICK

The House Fly, Musca domestica Linn., its Structure, Habits, Development, Relation to Disease and Control. By C. GORDON HEWITT. Cambridge: University Press.

The house fly has been an illustration of the fact that it is concerning the most common animals that we often know the least. Though associated with man through all ages, and doing him incalculable injury, this insect, until recently, was either viewed with complete indifference or rather with favor as a paragon of industry. To any one who desires to see how all of this has been changed and how fully the menace which the house fly forms to public health has been established, the book by Dr. Hewitt is highly recommended. It is not a popular treatise in the usual sense but, as the author states in the preface, it complements the work by Dr. L. O. Howard, "The House Fly: Disease Carrier." Although primarily intended for entomologists, sanitarians and physicians, it contains much matter of general interest.

The various parts of the book deal with the structure and habits of the house fly, its breeding habits, natural enemies, various related species frequenting houses, relation to disease and control. The strongest parts of the book appear to be those dealing with the anatomy and with the dissemination of dis-

eases. The author's work on the anatomy of the house fly began at the University of Manchester in 1905. A very satisfactory monograph which he published in 1907–8 is largely incorporated in the present work. On the subject of the muscular structure of the larvæ particularly, the contribution Dr. Hewitt makes is important. Previous writers generally have passed over this subject lightly. In fact the anatomy of the larvæ of insects has received but little attention. The principal previous work referred to the larva of the goat moth and was published in 1762. There are few investigators qualified to do such work on anatomy as has been done by Dr. Hewitt. His account not only widens our knowledge of insect structure, but corrects many errors which have been made by less competent observers.

The subject of the rôle of the house fly in the dissemination of disease is an extremely complicated one. It is not sufficient to determine the presence of pathogenic bacteria on the fly. Immediately questions of the viability of the bacteria and the habits of the fly must be considered before the actual importance of the insect in disseminating the germs can be considered settled. On this subject in the last few years masses of articles of the most diverse kinds have appeared. Dr. Hewitt analyzes the evidence and treats it in a conservative and judicial manner. His conclusions will undoubtedly be fully substantiated in the course of time. Even since the book was published much corroborative evidence has been supplied.

The book is written in a clear and effective style, is well balanced, well illustrated and altogether in keeping with the high reputation which the author enjoys.

W. D. Hunter

CONTRIBUTIONS TO MINERALOGY AND THE MINERAL SPRINGS OF JAPAN

The Japanese publication *Beiträge zur Mineralogie von Japan,* so ably conducted by Professor Tsunashirô Wada, offers in its fifth number, recently issued, several valuable contributions to the mineralogy of the Japanese empire. Although the title of this publication is in German, all of the articles, with the exception of some in the first number, have been written in English.[1]

Of especial interest is the first paper, by Nobuyo Fukuchi, "The Minerals of Chôsen (Korea)." It presents a summary of about sixty mineral species that have so far been discovered in Korea, among them the following precious stone materials, although hardly of gem-quality: garnet, beryl (?), tourmaline and zircon, as well as rock crystal, smoky quartz, amethyst, rose quartz, etc. Large quartz crystals, of a peculiar reddish hue due to inclusions, have been found at Hukuganzan, Keishô-nando, as have also amethyst crystals. Smoky quartz occurs at several places near Keishû, Keishô-hokudô, and in this region are rock crystals affording good material for lenses. Gold placers and gold veins occur at several places; one large nugget weighing about 915 grams (nearly 30 ounces) was found near Tansen and is noted in the *Journal* of the Geographical Society of Tokyo for 1912. Limonite, the chief iron ore of Korea, occurs in four places: The Kaisen iron mine in Heïan-hokudô; and the Inritsu, Sainei, and Kenjiho mines in Kokai-dô. Garnet has been found in the Suian gold mines in Kokai-dô and in the Inzan gold mines in Heïan-hokudô; columnar crystals of zircon occur in a graphite deposit at Jidô, Heïan-hokudô; and black tourmaline is found near the Sakushû gold mines, Heïan-hokudô, and at two other localities. The occurrence of graphite in the Gneiss system and the Korean system or in old Paleozoic sediments in Korea is also studied by Nobuyo Fukuchi. The graphite veins frequently consist of two symmetrical halves of similar structure with a boundary line between them, and graphite deposits of this type are of great purity and particularly valuable from an economic standpoint. The veins are believed to owe their formation to dissociation from neighboring graphite nests, caused

[1] *Beiträge zur Mineralogie von Japan,* ed. by T. Wada, No. 5, November, Tokyo, 1915; 101 pp., plate; pp. 207–305 of continuous pagination.

by the heat of the granite magma or by emanation gases.

Other papers are: "A Monoclinic Prismatic Sulphur from Reisuiko in Taiwan," by Masakichi Suzuki; "Studies on some Minerals of Japan," by Mikio Kawamura, giving a thorough exposition of the optical properties of danburite from Obira, Province of Bungo; "Epidote Crystals from Katakai in Sasaharamura, Province of Iwaki," by Kinzô Nakashima; "Ferberite from Kurasawa in the Province of Kai; and Hübnerite from Nishizawa in the Province of Shimo-tsuke," by Kotora Jimbô.

The description of two aragonite cones from a liparite region in the gold district of Kuriyama, by Watanabe (pp. 237–241, plate), illustrates two interesting examples of these cone formations at the outlet of geysers. One of these Kuriyama geysers emitted 4.26 liters of colorless hot water per minute, the temperature being 94° C.; about 44 grams of carbonate of lime are deposited in twenty-four hours, something like 4⅓ per cent. of the amount in the water. The cones are blunt-ended, and composed essentially of lime carbonate with a trifling admixture of sulphur. An interesting fact is the calcite structure of the inner or older part of these cones, in contrast with the very minute hexagonal columns of aragonite terminated by the basal pinacoid, forming the loose inner part of the lower portion of the cone. One of these specimens (Plate X., Fig. 1) was formed between August 26, 1907, and June 25, 1908; it is 30 cm. high, the diameter at base being the same; its weight is 13.878 kg.; the canal is not strictly vertical, but rather oblique. The second example (Fig. 2) has two canals, its dimensions being: height, 24 cm.; diameter at base 30 cm. According to local tradition a cone about 1½ meters high once stood at the same spot.

The precious opal of Hôsaka is briefly noted by Yônosuke Ôtsuki (pp. 274, 275). The locality lies in the upper course of the rivulet Kikôzugawa, which flows between the village of Hôkawa and the mountain-pass Kurumatôge. The opals are found within nodules (silicified spherulites) enclosed in a green-black pearlite which turns gray in weathering. The nodules are usually from 3 to 5 cm. in diameter, although some measure as much as 18 cm. across; they are brownish or black, resembling potatoes in shape, good opals coming more frequently from the brown than from the black nodules. The opal-material is here present in great variety: milk opal, opal-agate, precious opal, glass opal, as well as the smoky, obsidian-like variety, the yellowish-green, the waxy and others. Important is the granulated appearance of some specimens when viewed in a particular direction, the granules offering one interference color by incident light, while the cement assumes a different color. The specific gravity of the precious opal is 2.22, its hardness 5.5 and its aqueous content 8.49 per cent.

Crystals closely resembling the jarrowite from the Clyde-Estuary in Scotland have been found in Chinano province, Japan; to these have been given the name, *gennô-ishi,* or hammerstone.[2] Both are judged to be pseudo-gaylussite, or calcite after gaylussite, the peculiar shape having led anthropologists to designate such crystals "stone-axe." The *gennô-ishi* crystals of Shinano province are acute pyramidal or prismatic with very rough, curved surfaces. There are deep parallel striations on the crystal faces, perhaps sutures of oscillating combination, and also many small sub-crystal protuberances, placed in parallel order; it seems that sometimes a crystal was formed by an aggregation of many of these parallel individuals.

In color the Clyde crystals differ somewhat from the Japanese, the former being deep brown with resinous luster and the latter light brown with a like luster. A comparison of the chemical composition is given by the following analyses, there being a considerable undetermined residue in the case of the Shinano crystals and in Clyde No. I., which may represent organic matter.

[2] Tadusu Hiki, "On the Genô-ishi"; reprint from the Memoirs of the College of Engineering, Kyôto Imperial University, Vol. I., No. 2, Kyôto, 1915; plate.

	Shinano	Clyde	
		I	II
SiO_2	0.64	0.12	.....
Fe_2O_3	3.44	5.36	.....
Al_2O_3	1.00	0.12	.....
CaO	52.33	46.60	47.63
MgO	0.48	4.94	4.21
CO_2	37.00	36.40	39.91
P_2O_5	.....	.....	2.23
Organic matter	.....	.....	5.94
	94.89	93.54	100.22[3]

An exceedingly comprehensive work on the mineral springs of Japan has just been published by Dr. R. Ishizu, expert of the Imperial Hygienic Laboratory at Tokyo.[4] No less than 1,201 of these springs are tabulated, and a very large number of analyses are given, as well as tables of the radioactive springs of Japan, and of the leading European springs of this interesting class. Part III. offers notes on prominent spas and resorts. The numerous plates illustrate the scenic beauties of the various localities.

George F. Kunz

SPECIAL ARTICLES

ANTAGONISTIC ELECTROLYTE EFFECTS IN PHYSICAL AND BIOLOGICAL SYSTEMS[1]

The purpose of this paper is to summarize briefly certain experiments regarding the influence exerted by antagonistic electrolytes on emulsions and other physical systems, and to compare the data in question with those available regarding the influence exerted by the same antagonistic electrolytes on living cells, in an attempt to throw some light on the physical structure of protoplasm and the mechanism of certain vital processes.

In spite of the accumulation by Jacques Loeb, and other biologists, of a large amount of accurate experimental data regarding the effects exerted by electrolytes, singly and in combination, on living cells, there is, at present, no generally accepted physical explanation for the antagonistic or compensatory effects exerted by electrolytes on one another in biological systems.

In a preliminary communication published in 1913 based on certain physical and biological experiments, details regarding which will be found in a subsequent section of this paper, it was concluded that, with certain exceptions to be considered later, electrolytes may be divided, as regards their effect on the protoplasmic membrane, into two main antagonistic groups according to whether, like $CaCl_2$, they possess a more readily adsorbed or reactive cation, or, like NaOH, NaCl, etc., a more readily adsorbed or reactive anion. Substances of the former class appear to diminish the permeability of the membrane to water, while those of the latter class increase the permeability of the membrane. As will be seen later, the ratios in which antagonistic electrolytes counterbalance one another in biological systems correspond so closely with the ratios in which they balance one another in physical systems as to suggest the probability that balanced electrolyte solutions, like sea-water and the blood of mammals, are those in which the proportions of cations and anions adsorbed on or reacting with the protoplasmic membrane are equal, or at least compensatory, with the result that the colloidal equilibrium, and consequently the permeability of the membrane, remains unchanged. A somewhat similar conclusion was reached by Osterhout as a result of experiments on the electric conductivity of laminaria tissues. Under comparable experimental conditions the tissues which had been exposed to sea-water exhibited a practically constant resistance to the passage of an electric current, but, after exposure to solutions of

[3] The summation is .30 in error, which exists in the manuscript.

[4] "The Mineral Springs of Japan," with tables of analyses, radioactivity, notes on prominent spas and list of seaside resorts and summer retreats, specially edited for the Panama-Pacific International exposition, by Dr. R. Ishizu, expert of the Imperial Hygienic Laboratory, Tokyo Imperial Hygienic Laboratory, 1915, x + 94 + 203 + 70 + 8 pp., maps and illust., and 76 plates, folio.

[1] A summary of a paper read before the Biological-Chemical Society, Boston, Mass., December 28, 1915. Received for publication December 29, 1916. Publication delayed on account of necessity of condensation within suitable dimensions for this journal. (From the Biological-Chemical Laboratory of the State Institute for the Study of Malignant Disease, Buffalo, N. Y.)

NaCl, a markedly decreased resistance, and after exposure to solutions of $CaCl_2$, a markedly increased resistance, at least for a short period; but there was no appreciable variation from the normal after exposure of the tissues to mixtures containing NaCl and $CaCl_2$ in the ratios of 100 molecules of the former to one or two of the latter. Osterhout concluded as a result of these and other experiments that electrolytes may be divided into two main antagonistic groups according to whether they raise or lower the permeability of the protoplasmic membrane.

The ratio of 100 molecules of NaCl to 1 or 2 molecules of $CaCl_2$ is one of peculiar significance in biology. NaCl and $CaCl_2$ occur in approximately this ratio in sea-water, the blood of mammals, and other saline media capable of supporting life. Furthermore, marine organisms are killed by transference to artificially prepared solutions of NaCl or $CaCl_2$ isosmotic with sea-water, but they remain uninjured if transferred to a solution of NaCl to which enough $CaCl_2$ has been added to give the ratios in question.

The writer's experiments on emulsions start from an observation made by Bancroft that soaps of Na, used as emulsifying agents for oil and water, give an emulsion consisting of drops of oil dispersed in water like cream, while soaps of Ca exert the reverse effect, producing emulsions consisting of drops of water dispersed in oil like butter. The writer believed that these experiments might offer a physical explanation for the antagonistic effects exerted by salts of Na and Ca on one another, not only in biological systems of the type described above, but also in such purely physical processes as blood coagulation and the production of a casein clot. In the coagulation processes in question the transformation of a suspension of a protein dispersed in water, into a clot in which water is more or less dispersed in an outer or continuous protein phase is promoted by salts of Ca and inhibited or retarded by alkalies and salts of Na. Therefore the first question to determine was whether a similar transformation could be effected in the case of emulsions. In the preliminary paper referred to above the writer was able to demonstrate that suitably constituted emulsions of oil dispersed in water could be converted into emulsions of water dispersed in oil by shaking with salts of Ca, and that the transformation in question could be prevented, or a reverse transformation effected, by shaking with an adequate proportion of NaOH. It was subsequently demonstrated that NaCl, and other salts of Na, exert an effect on emulsion systems similar to that of NaOH but considerably weaker. The processes of blood coagulation and emulsion transformation appear to be similar physical effects promoted by salts of Ca and inhibited by alkalies and salts of Na. In both cases, a system consisting of a non-aqueous phase dispersed in water is converted, more or less perfectly, into a system consisting of water dispersed in the non-aqueous phase, analogous to the transformation of islands surrounded by water into lakes surrounded by land. It is obvious that a system of islands surrounded by water is freely permeable to water and water-borne substances, while a system of lakes surrounded by land is absolutely impermeable. A variety of intermediate systems exhibiting any desired degree of permeability can well be conceived. Since salts of Ca promote a transformation in one direction and alkalies and salts of Na in the reverse direction, it appears probable that by simply varying the proportions of the salts in question introduced into a given system it should be possible to vary the permeability of the system to water to any desired extent. Since variations in the permeability of protoplasm induced by variations in the proportions of salts of Ca and Na appear from Osterhout's experiments to account for the destructive effects exerted by salts of Ca and Na when used individually, and the protective effect exhibited when these substances are used jointly in ratios of 100 molecules of NaCl to 1 or 2 of $CaCl_2$, the question arises how far can such a mechanism as that described above in the case of emulsions and blood coagulation explain protoplasmic structure and function?

From what we know of protoplasm and the protoplasmic film it is by no means incon-

ceivable that the former approximates to a dispersion of proteins, fats, lipoids, and other colloids in water, while the latter approximates to the reverse type of system in which water is more or less dispersed in an outer or continuous phase of fats, lipoids, and possibly proteins. Arguments in support of the view that protoplasm when first formed is a system relatively freely permeable to water because water is the outer or continuous phase are, first, the active Brownian movement exhibited by protoplasm when inspected by means of the ultra microscope; and, second, the freedom with which water-soluble substances, artificially introduced through the protoplasmic film, permeate the protoplasmic material. Arguments in support of the view that the protoplasmic film is relatively impermeable to water, because water is more or less dispersed in an external or continuous phase, consisting at least in part of fats and lipoids, are, first, the resistance offered by the protoplasmic film to the passage of salts, sugars, and other water-soluble substances; second, the resistance to the passage of an electric current; third, the phenomenon of osmotic pressure; fourth, the variations in the proportions of given electrolytes within and without the cell; and, fifth, the freedom with which anesthetics and other fat solvents penetrate the protoplasmic system. Since the variations in permeability of protoplasm under the influence of salts of Ca and Na may well be attributable to a reversal of phase relations analogous to that observed in the case of emulsions, sols and jellies, the next question to determine is whether given electrolytes exert antagonistic effects on physical systems in the same ratios as on living cells. Before describing the experiments, it is necessary to refer briefly to the explanation offered by Bancroft for the apparently antagonistic action of soaps of Na and Ca in emulsion systems. Pure oil and water when shaken together do not give a permanent emulsion. Soap or some other so-called emulsifying agent must be employed. The emulsifying agent exerts its effect by concentration at the interface between oil and water, forming a film which prevents the subsequent coalescence of the dispersed particles. Bancroft concluded that soaps of Na, which are freely dispersed in water but not in oil, form a film which is wetted more readily by water than by oil, with consequently a lower surface tension on the water than on the oil side, and, since the area of the inside face of a film surrounding a sphere is smaller than that of the outside face, the film will tend to curve in such a manner as to enclose globules of oil in water, thus reducing the area of the side of higher surface tension to a minimum as compared with that of lower surface tension. Conversely, a film composed of Ca soap, which is freely dispersed in oil but not in water, is wetted more readily by the oil than by the water, the surface tension is lower on the oil than on the water side, and the film tends to curve in such a manner as to enclose the globules of water in an outer or continuous oil phase.

While studying reversible emulsion systems, the writer observed that when those electrolytes, like $CaCl_2$, that promote the formation of an emulsion of water in oil are present in such proportion as to balance those, like NaOH or NaCl, that promote the formation of an emulsion of oil in water, a critical point is recognizable at which neither type of emulsion predominates, and the oil and water separate rapidly under the influence of gravity into two layers. This observation affords a strong support of Bancroft's conclusion. Since the electrolytes in question are exerting an exactly compensatory effect on the film it has no tendency to curve in either direction, and, since it remains straight, neither phase is capable of surrounding the other. The mixture shaken together really contains two continuous phases analogous to the fiber and air in a sponge, and, since oil and water are both fluids, they separate readily under the influence of gravity.

Salts of divalent and trivalent cations, and, under certain circumstances, small amounts of acids appear to function in the same way as salts of Ca, promoting the formation of emulsions of water in oil. Alkalies, salts of monovalent cations, and of di- and trivalent anions, appear to function similarly to NaOH, promoting the formation of emulsions of oil in

water. Studies carried out by means of emulsions of oil and water are altogether too crude to determine the exact ratios in which antagonistic electrolytes exert compensatory effects. After experimenting with various procedures the following method was finally adopted. Aqueous solutions containing NaOH or Na oleate were allowed to run from a Traube stalagmometer or capillary pipette through olive oil containing a certain amount of fatty acid. If solutions of suitable strength were employed, surface films of soap were produced at the interface between oil and water, when the aqueous solution flowed out of the orifice of the pipette and came in contact with the surrounding oil. The size of an individual drop formed, and, since the volume is constant, its inverse the number of drops, depended upon the concentration of the NaOH employed. A $M/1{,}000$ NaOH solution gave from 40 to 45 drops, while one of half this strength gave from 20 to 25 drops, and one of double the strength gave several hundred drops or ran through the oil in a stream without the formation of any drops whatever. If NaCl was added to a given system of this type, the number of drops was rapidly increased, as will be seen from the accompanying table. If $CaCl_2$ was added to such a system the number of drops was diminished, but when NaCl and $CaCl_2$ were employed together they appeared to exert a compensatory effect upon one another in the proportions of 100 molecules of NaCl to one or two molecules of $CaCl_2$, according to the concentration of the solution employed. (See table.)

TABLE

Exper. No.	Concentration of			No. of Drops	Mol. Ratio NaCl : $CaCl_2$
	NaOH	NaCl	$CaCl_2$		
1	.001M	—	—	44	
2	.001M	.15M	—	300	
3	.001M	—	.0015M	24	
4	.001M	.15M	.0015M	44	100 : 1
5	.001M	.3M	.003M	43	100 : 1
6	.001M	.45M	.005M	43	100 : 1.1
7	.001M	.6M	.01M	43	100 : 1.6

To avoid any possibility of confusion, or any idea that this antagonism between $CaCl_2$ and NaCl is due to an antagonism between Ca and Na, the writer wishes to emphasize particularly the fact that these antagonistic effects are always attributable to a balance between cations, on the one hand, and anions, on the other, adsorbed on or reacting with a surface film or membrane. It simply happens that, in the case of $CaCl_2$, the cation Ca is far more readily adsorbed than the anion Cl, while, in the case of NaCl, the anion Cl is somewhat more readily adsorbed than the cation Na. The effect obtained from each individual salt is a resultant of the relative adsorption of cation and anion; and the effect obtained from an admixture of two or more salts is the resultant of the relative adsorption effects exerted by all the cations and anions involved. It will be seen therefore that, while $CaCl_2$ exerts an effect like an acid on account of its dominant cation, NaCl exerts an effect like an alkali on account of its dominant anion.

The remarkable correspondence between the ratios in which NaCl and $CaCl_2$ balance one another in these purely physical systems and in the biological systems referred to above led the writer to investigate further the relations exhibited by a variety of electrolytes known to exert antagonistic effects in biological systems. In several hundred experiments, full details regarding which will shortly be published, the writer has been able to duplicate the results obtained by Loeb, Osterhout, Lillie and numerous other biologists, on living cells. The ratios and proportions in which substances having a dominant cation antagonize substances having a dominant anion are approximately the same in the great majority of comparable physical and biological experiments. For convenience in describing experiments those substances having a dominant cation, which diminish the dispersion of the film in water, thus rendering the system less permeable to water, are termed "protective," those having a dominant anion, which increase the dispersion of the film in water, thus rendering the system more permeable to water, are termed "destructive." Even those substances like salts of Mg, and certain non-electrolytes, the anesthetics, which exhibit abnormalities in biological systems, functioning under varying

conditions and varying concentrations as protective or destructive agents, exhibit similar abnormalities when tested by means of the drop system described above. $MgCl_2$, for example, when employed in a drop system in conjunction with Na oleate, lowers the number of drops, exerting an antagonistic effect against NaCl virtually the same as that exerted by $CaCl_2$. When employed in a NaOH system, the $MgCl_2$ acts like NaCl, causing however a far greater rise in the number of drops than NaCl. This effect may be counteracted by means of $CaCl_2$ in proportions varying according to circumstances from one of $CaCl_2$ to one to four of $MgCl_2$. Anesthetics generally exert an effect like salts of Ca, and counteract the destructive effect exerted by NaCl on the film, but, under certain peculiar conditions and at considerably higher concentrations, they may exhibit a destructive effect on the film, causing an increase rather than a decrease in the number of drops. This result is of interest in view of the observation made by Lillie that anesthetics exert protective effects on *Arenicola* larvæ at certain concentrations, and destructive effects at other concentrations; particularly since the proportions in which given anesthetics exert an optimum protective effect on the drop film in our experiments, as indicated by the minimum number of drops, appear to correspond fairly closely with those observed by Lillie. These somewhat remarkable effects are being studied further in the hope of securing an insight into the exact nature of the mechanism involved. These experiments indicate that anesthesia is due to a diminution in the permeability of protoplasm. If the relative effects exerted by monovalent, divalent and trivalent cations are compared, it is found that Ca exerts from twenty to thirty times as great a protective effect on the film as Na, and Fe from 100 to several hundred times as great a protective effect as Na. Mono-, di-, and trivalent anions exhibit similar but less readily recognized ratios. Acids and alkalies exhibit the same peculiarities in these systems as in biological and colloidal systems, the H and OH ions being apparently much more active than other monovalent ions, and, in certain cases, exhibiting a greater activity than di- or trivalent ions. Weak acids and weak bases exert far less effect than strong acids and strong bases, and the ratios correspond fairly well with the probable concentration of the H or OH ion. The fact that NH_4OH exerts vastly less effect that NaOH, while in biological systems NH_4OH penetrates the protoplasm far more readily than NaOH, is readily explained when we remember that the penetration of NaOH depends upon a destructive effect exerted upon the protoplasmic structure resulting in an actual increase in the permeability of the system to water-borne substances, while NH_4OH presumably penetrates the protoplasmic system on account of its being dispersed or dissolved to a certain extent in the non-aqueous phase.

A single experiment has been selected from a comparative series carried out on animals, on the blood coagulation process, and on the drop system, in order to show that antagonistic electrolytes exert comparable effects in physical and biological systems. $CaCl_2$ and Na citrate were selected for this purpose, not because similar results could not have been obtained by the employment of $CaCl_2$ and NaCl, but because the high concentrations of NaCl required would have exerted a disturbing effect. By mixing a M/10 $CaCl_2$ solution with a chemically equivalent citrate solution in varying proportions, it was ascertained that they exert a compensatory or balancing effect upon one another in the various systems described, when present in the proportions of approximately one equivalent of $CaCl_2$ to two equivalents of Na citrate. $CaCl_2$ in excess of this proportion gave a number of drops less than that given by the original system, Na citrate in excess of this proportion gave a larger number of drops, but when $CaCl_2$ and the equivalent citrate solution were employed in ratios of 1:2, the number of drops obtained corresponded closely with that given by the original system. When the same solutions were injected into the tail veins of mice, it was found that the fatal dose of either the $CaCl_2$ or citrate solution alone was from .25 to .3 c.c. The amount required to cause the death

of the mice rapidly increased when citrate was admixed with $CaCl_2$, or when $CaCl_2$ was admixed with citrate, until finally, when the solutions were employed in the ratios of one equivalent of $CaCl_2$ to two of Na citrate, a destructive effect on the mice could only be observed when, by greatly increasing the concentration, the dose employed was raised to 40 or 50 times that used at either end of the scale. In the process of blood coagulation, all the plasma tubes employed were coagulated rapidly when $CaCl_2$ was present in excess of the ratio of 1:2, while no coagulation took place in those tubes in which the proportion of $CaCl_2$ was below this figure. From the remarkable similarity exhibited in these three systems, one purely physical, one purely biological, and one semi-physical and semi-biological, it may well be concluded that the equilibrium of both physical and biological systems of the type described depends upon the maintenance of the colloidal equilibrium of surface films, and that balanced solutions are those in which the proportions of cations or anions adsorbed on or reacting with the colloidal constituents of the film are compensatory, and consequently no change occurs in the equilibrium of the system.

These drop systems are peculiarly sensitive to changes in physical conditions and to slight variations, such, for example, as an increase or decrease in the proportion of fatty acid present in the olive oil employed. These variations are of peculiar interest as offering a possible explanation for the variations in permeability to food stuffs of actively growing cells, conditioned not only by variations in the proportions of electrolytes and of metabolic products in their environment, but also by slight variations in the proportions, for example, of lipase or any agent capable of splitting fats or lipoids. In fact these systems are as delicate, or even more delicate than living cells, and are equally difficult to work with. Accurate comparative data can only be obtained by the most scrupulous observance of every possible precaution to insure comparable working conditions, and by taking the average of a very large number of experiments. It is interesting to note in this regard that in such a series of experiments the great majority will lie within a close range of the average, while in certain individual experiments, as in the case of certain individual organisms, extraordinary abnormalities may be exhibited. It is not possible in this brief preliminary communication to explain fully the mechanism of the drop system, but it may be stated briefly that those forces which promote an increase in the number of drops are always comparable with those which promote the formation of emulsions of oil in water or a system more permeable to water, while those which exert the reverse effect causing a diminution in the number of drops are those which promote the formation of emulsions of water in oil or a system relatively less permeable to water. This is due presumably to the influence exerted by various reacting or adsorbed anions or cations on the relative dispersion of the constituents of the film in water, on the one hand, and oil, on the other, thus changing the relative surface tension on the two sides of the film, and promoting the formation according to circumstances of a system in which the permeability to water and water-borne substances is increased or diminished.

To turn now to the question as to how this bears on the problem of protoplasmic structure: it is probable that not only soap films, but all concentration films formed at the interface between two non-miscible phases, tend to be more or less similarly influenced by adsorbed substances. It is not proposed at this stage to consider the case in which the effects produced are simply due to an electric charge conveyed by adsorbed cations or anions, a subject which will be dealt with in a subsequent communication, but simply those cases in which definite soap films are formed and play a rôle in conditioning the equilibrium of the system. We know that fats and lipoids play an important rôle in the protoplasmic film. We know that soaps are present in the protoplasmic system, and, since the soaps in question will tend to concentrate, as has been seen above, at the interface between the particles of fatty or lipoid material and water, it is quite

conceivable that, when naked protoplasm comes in contact with an environing medium, like sea-water, capable of supporting life, the dispersed particles of fatty or lipoid material which find themselves immediately on the surface in contact with the sea-water are immediately influenced by the Ca in the sea-water. The system which consists of fatty or lipoid material, dispersed by means of a soap film in water, might be converted more or less perfectly into the reverse type of system, in which water is dispersed by means of a soap film in an external fatty or lipoid phase. The permeability of such a system to water, the extent to which water channels would be formed from point to point through such a film or membrane, might well depend on the proportions of those electrolytes like $CaCl_2$, on the one hand, which tend to render the system less permeable, and those like NaCl, on the other, which exert the reverse effect. Taking as an example the conversion of a dispersion of particles of wax in water into a honeycomb-like structure in which the water phase is surrounded by the continuous wax walls of the cells, it can readily be appreciated that any agent capable of corroding or perforating the walls of the honeycomb structure would promote the continuity of the previously dispersed water phase, and ultimately open up water channels of communication throughout the whole system. Agents capable of exerting the reverse effect, tending to protect the wax walls, would obviously antagonize the agents corroding or breaking down the walls, with the result that the permeability of such a system would depend ultimately upon the proportions in which the antagonistic agents in question are present in the system. The writer believes that a somewhat similar explanation might be found for the formation of the protoplasmic film, and that the antagonism between electrolytes possessing a more readily adsorbed cation, which tend to promote the formation of a less permeable system, and those possessing a more readily adsorbed anion, which tend to exert the reverse effect, may be accounted for on the lines indicated.

Proteins present in protoplasm being transformed under the influence of Ca into a non-reversible system analogous to a blood clot might well form a sort of framework and confer a certain rigidity, elasticity, and continuity to the membrane structure. Fatty or lipoid materials which produce readily reversible emulsion systems in conjunction with water, when supported by a protein framework, might yield a system sufficiently sensitive to exhibit variations in permeability to water under the influence of varying proportions of such antagonistic electrolytes as NaCl and $CaCl_2$.

CO_2, and other products of metabolism, exert a profound effect upon the equilibrium and relative surface tension relations of interfacial soap films, and it is hoped in a subsequent publication to demonstrate that, under the influence of variations in the proportions of products of metabolism and electrolytes at given points in the system, rhythmical variations in permeability may be produced in the protoplasmic film permitting of the intake of food stuffs and output of waste products, and functioning in a manner somewhat analogous to the valve system of an engine or machine. If we consider the analogy of such a valve system, since the efficiency of a mechanical system may be entirely destroyed by too greatly increasing or too greatly diminishing the size and speed of action of the valves, it is not difficult to understand how substances like $CaCl_2$, by diminishing the permeability, and substances like NaCl, by increasing the permeability of the protoplasmic membrane beyond those comparatively narrow limits within which vital functions may be performed, would ultimately cause a sufficient disturbance of colloidal equilibrium to bring about what we designate as the death of the cell. The variations in electrical potential exhibited between the inside and outside of the cell, and the electrical effects exerted by given salts correspond with this theory. These experiments with antagonistic electrolytes afford substantial support to the theory, first advanced by A. B. Macallum, that the similarity in the proportions of certain electrolytes in sea-water, the blood of mammals, etc., is attributable to the fact that living protoplasm

has inherited from its original protoplasmic ancestor an adjustment of colloidal equilibrium to those electrolytes which were present in sea-water at the time that protoplasmic material first came into being. In other words we may say that electrolytes play, and always have played, an extremely important rôle in conditioning the form and structure, and maintaining the equilibrium of the complex colloidal system which we designate as living protoplasm. For further details regarding these and other experiments, and the methods employed, reference must be made to a paper in the May number of the *Journal of Physical Chemistry* and to other papers which will shortly appear in the *Journal of Physical Chemistry*, the *American Journal of Physiology*, etc.

In conclusion the writer wishes to acknowledge his great indebtedness to Mr. F. West for his cooperation in the conduct of the experiments recorded in this communication.

G. H. A. CLOWES

THE ORGANIZATION OF THE PACIFIC PHYSICAL SOCIETY

THE first meeting of the Pacific Physical Society was called to order by Professor Fernando Sanford at 3 o'clock on March 4 in Room 370, Stanford University Quadrangle. Forty members of the various departments of physics, physical chemistry and chemistry of the Pacific coast universities were present.

Professor E. P. Lewis, of the University of California, was called to the chair, and the following program was presented:

The Electromotive Force produced by the Acceleration of Metals: RICHARD C. TOLMAN and T. DALE STEWART.

This paper described some experiments on the mass or inertia of the carriers of electricity in metals. Similar effects have been looked for by previous investigators, Maxwell,[1] Lodge[2] and Nichols,[3] without apparatus sensitive enough for the purpose.

[1] Maxwell, "Treatise on Electricity and Magnetism," 3d ed. (1892), Vol. II., pp. 211 *et seq.*

[2] Lodge, "Modern Views of Electricity," 3d ed. (1907), p. 89.

[3] Nichols, *Physik. Z.*, 7, p. 640 (1906).

A coil of wire was rotated about its axis and suddenly brought to rest. The two ends of the rotating coil were connected through an external circuit with a highly sensitive ballistic galvanometer and the deflection of the galvanometer noted when the coil was stopped, the pulse of electricity thus measured being produced by the tendency of the electrons in the wire to continue in motion after the rest of the coil was at rest. A number of serious accidental effects had to be eliminated.

From the results of the measurements it was possible to calculate the effective mass of the electron in copper, silver and aluminum, the values obtained being not far different from that of the mass of the electron in free space.

The authors believe that their results are in accord with the "free electron" theory of metallic conduction and present serious obstacles to Sir J. J. Thomson's[4] recent theory of the conducting process in metals.

Contact Electromotive Force of Amalgamated Metals: F. J. ROGERS.

Electromotive Force of Metallic Sulphide Electrodes: S. W. YOUNG and W. E. BURKE.

Change of Potential of the Same Metal in Different Electrolytic Solutions: PHILO F. HAMMOND.

Voltaic cells were formed by using platinum electrodes for both the cathode and the anode, but with different salt solutions surrounding each electrode, the two solutions being connected by a capillary tube or a gelatine partition. One tenth normal solutions were used in every case. Each

Metallic Ion in Nitrate Solution Used	When Measured Against Silver Nitrate	When Measured Against Potassium Nitrate	Single Electrode Potentials with Silver Reduced to Zero
Ag	0	0.658	0
Fe[5]	0.114	0.544	?
Cu	0.392	0.266	0.44
H	0.509	0.149	0.77
Pb	0.537	0.121	0.92
Ni	0.560	0.098	0.985
Co	0.565	0.093	0.99
Fe[6]	?	?	1.10
Cd	0.594	0 064	1.19
Zn	0.600	0.058	1.54
Mg	0.623	0.035	2.54
Ca	0.632	0.026	2.94
Ba	0.647	0.010	3.44
Na	0.653	0.005	3.90
K	0.658	0	3.94

[4] Sir J. J. Thomson, *Phil. Mag.*, 30, 192 (1915); see also Richardson, *Ibid.*, 30, 295 (1915).

[5] Ferric nitrate.

[6] Ferrous nitrate.

salt solution was measured against both silver nitrate and potassium nitrate.

After making certain corrections the above results were obtained from the measured differences of potential of the two electrodes.

Column three was derived from tables.

A curve was plotted using column one as abscissæ and column three as ordinates.

Notice that the ferric ion does not fall in the position usually given to iron, but in a position near the silver, actually between antimony and mercury.

The Pressure of Sound Waves: E. P. Lewis.

The Passive State of Iron in Nitric Acid: Joseph G. Brown.

It seems evident that the only hope of explaining the passive state of metals lies in the detailed study of the process by which some particular metal becomes passive in some particular solution. Accordingly such a study has been made for iron in nitric acid solutions. The E.M.F. of the primary cell: Iron/HNO_3 solution/concentrated HNO_3/platinum, has been measured at room temperature from the instant that it was made until it reached a steady state, using eight densities ranging from 1.01 to 1.41, both with the iron at rest and in motion. Observations were made with a low power microscope upon the changes which took place on and around the iron.

The results show that the ferrous oxide which forms on the iron at the start in all acid densities does not affect the E.M.F. of the cell, but the liquid products do. If the iron is kept at rest in acids up to 1.17 the E.M.F. is increased by the presence of the ferrous nitrate, while in acids denser than 1.17 the E.M.F. is lowered by some other product which forms a bright red liquid film over the oxidized surface of the iron. It is thought that this may be the unstable compound formed by the absorption of nitric oxide by ferrous nitrate, and the existence of this compound determines the semi-passive state.

In acids of greater density than 1.25 there is an explosive reaction between the ferrous oxide and the red liquid, after which the iron is in the passive state. The E.M.F. falls very quickly to a minimum and then rises very slowly to an extremely constant value.

It seems probable that both the ferrous and ferric reactions take place in acids of all densities, but in those greater than 1.25 the ferrous reaction may be quenched by the sudden reaction between the ferrous oxide and the red liquid, while the ferric reaction remains.

There is no indication of the existence of any kind of a film after the passive state is reached, but the gradual change in E.M.F. seems to indicate the expulsion of a gas from the iron after the state is reached.

If the explanation given is correct it allows the interesting conclusion that iron is "active" whenever the conditions are such that the ferrous ions are formed, but it is "passive" whenever these ions are not formed. This means that iron is essentially ferric and the chemical and electrical action of iron under ordinary circumstances is due to the existence, or formation, of ferrous iron at the surface. The E.M.F. measurements obtained would thus place ferrous iron in the electrode potential series between cadmium and cobalt, which is usually ascribed to iron, while ferric iron falls between antimony and mercury.

The fact that all those properties of iron which depend upon its cohesion make it more like platinum than like zinc, and the fact that comparisons of the potential of the same metal in ferrous and ferric salts place the ferrous and ferric iron in these same positions in the series, seem to confirm the conclusion.

If the significant thing about a valence is a number of electrons, it would seem that the surface molecules lost an electron under certain conditions but not under other conditions.

Conductivity of Paints: Raymond B. Abbott.

A Possible Method for the Detection of Gravitational Effect on Electrons: Lloyd T. Jones.

A Formula for Computing a Cohesion Constant: P. A. Ross.

At the Berkeley meeting of the American Physical Society in 1915 a paper was presented by the writer on the "Law of Cohesion in Mercury," in which it was found that the cohesion forces in mercury varied inversely as the sixth power of the distance. A value of the cohesion force was computed from the specific heat and coefficient of expansion which integrated on vaporization to a value agreeing well with the latent heat of vaporization.

In the present paper it is shown that from the principle of equipartition of energy in a vapor the same cohesion constant may be computed, the formula being

$$K = 7.5 \frac{p}{dD^{5/3}} \cdot \left(\frac{M}{N}\right)^{8/3},$$

where p is the vapor pressure; M, molecular weight; N, number of molecules per gram molecule; d, density of the vapor; D, density of the liquid; K, cohesion force between a vapor molecule and the liquid surface.

From this equation another constant, F, representing the force between two *single molecules* was found to be given by the equation

$$F = \frac{pM^{2/3}}{dD},$$

where the letters have the same meanings as before. At the critical point this becomes

$$F = \frac{pM^{2/3}}{D^2}.$$

This constant is directly proportional to the constant "a" in Van der Waals's equation and nearly proportional to the Rankine, Heydweiller and Kleeman constants.

A New Automatic Mercury Pump: W. P. ROOP and L. T. JONES.

Two Small Communications on Galvanometers: W. P. ROOP.

(*a*) The reduction factor and resistance of a sensitive galvanometer may be quickly and conveniently determined by means of a decade bridge. Galvanometer and battery are connected to the appropriate binding posts, as in the ordinary use of the bridge. The binding posts to which the unknown resistance is ordinarily connected are left free. Two settings of rheostat resistance and the corresponding galvanometer readings yield the required result.

Approximations are as follows: One ratio arm is neglected in comparison with the other. Battery resistance is neglected in comparison with that of the high ratio arm. Battery E.M.F. is taken as constant. The deflections of the galvanometer are supposed proportional to current. Failure to meet this last condition can be remedied by applying a process of successive approximation to the calculations.

(*b*) The sensitiveness of a galvanometer may be doubled by doubling the scale distance and placing the telescope close to the mirror. As compared with other means of increasing the sensitiveness[7] this scheme has the following advantages: It requires no change in the galvanometer. It brings the observer close to the instrument. It enlarges, rather than diminishes, the field of view, or, if desired, permits the use of a smaller mirror. It introduces none of the difficulties of the other method which arise in multiple reflection.

[7] Geiger, *Physikalische Zeitschrift*, January, 1911.

Some Properties of Thin Films: W. P. ROOP.

An attempt to observe a change in ohmic resistance of a thin film on illumination with ultraviolet light resulted negatively. Such a change might be anticipated as a result of photoelectric emission. Diminution in density of free electrons might increase resistance, or liberation of bound electrons might result in decrease.

Other phenomena were observed, however, for which no simple explanation has been found. These include: (*a*) Spontaneous change in resistance of the film. (*b*) Negative temperature coefficient. (*c*) A quasi-polarization effect. The film was connected like a condenser, first with a dry cell, and then with a galvanometer. The galvanometer showed ballistic deflections which diminished approximately logarithmically with increasing time interval between disconnection from cell and discharge. The half-value period was about two seconds. (*d*) Fluctuations in the resistance of the film. In a typical case, there was a variation of the order of 1 per cent. in the resistance of a film of 2×10^6 ohms. The fluctuation was entirely spontaneous, uninfluenced by small temperature changes and by the nature of the gas in contact with the film. It covered a wider range at higher resistances.

Oxidation has an undoubted effect on the phenomena observed. All were present, however, in high vacuum and hydrogen as well as in air. Substances most used were nickel and zinc. Observable tarnish of the surface was in no case apparent.

A recess was declared at 6 o'clock in order to enjoy a delightful dinner, served in the Faculty Club house on the campus. After the dinner members listened to the paper by Professor Sanford.

The Specific Inductive Capacity of Certain Metals: FERNANDO SANFORD.

It is well known that in the spectra of a number of metals series of lines have been found whose wave-lengths may all be computed from a simple formula. In all these cases the wave-lengths converge towards a shortest possible wave-length for the series. In the group of the alkali metals a spectral series whose convergence wave-length is shorter than any known wave-length in the spectrum of the respective metal is known for each element. It is assumed in the paper that these convergence wave-lengths represent the shortest wave-lengths that can exist in their respective

atoms, and that the orbital radius of the electron whose vibration frequency would give the convergence number is the true radius of the central positive atom.

Heydweiller has computed the atomic diameter of a large number of elements from the volume occupied by their dissociated ions in a very dilute water solution. Heydweiller's atomic radii are accordingly here taken as the orbital radii of the electrons whose vibration frequencies would give the convergence numbers of Kayser's "Principal Series" in the alkali metals, and the centripetal forces required to hold these convergence electrons in their orbits are calculated. Then, assuming the inverse square law for the attraction between an electron and its central positive charge, the force of attraction upon an electron at unit distance from the center of its orbit is calculated for each element.

If the central positive charges of the atoms were the same for different elements, then these central forces should be the same. They are found not to be the same.

The positive charges of these atoms have previously been computed by the writer from electrolytic data. The charges here computed are not proportional to those formerly computed, hence the assumption that the atoms of the different elements have different specific inductive capacities seems to be justified. These specific inductive capacities may be computed by dividing the charges of the atoms by the respective forces which they exert upon an electron at unit distance.

The specific inductive capacities are calculated in this way for the thirteen elements for which convergence numbers, atomic radii and atomic charges have been computed. Since it is only for the alkali metals that the convergence numbers used are known to belong to the principal, or inner, spectral series, it is only to these elements that we can be sure that the above arguments apply. However, the computed specific inductive capacities are proportional to the serial numbers of Rydberg for ten of the thirteen elements, and for the other three, viz.; zinc, cadmium and thallium, they increase with the serial numbers just half as fast as they do in the case of the other elements.

The specific inductive capacities here computed are also shown to vary with the same atomic properties which vary with the measured specific inductive capacities of non-metallic elements.

It is also shown that the specific inductive capacities of these elements are proportional to their respective atomic radii. This would make the centripetal force upon electrons revolving about and very near to these different atoms proportional to the inverse third power of their orbital radii. This is shown to be the relation that must hold in order that the kinetic energy of different electrons shall vary as their frequency, as is assumed in Planck's Law and is apparently shown in the case of electrons expelled by the action of ultra-violet light upon metals.

The *relative* specific inductive capacities which have been calculated as above are given in the following table:

Element	k	Element	k	Element	k
Li	35.9	Mg	134	Zn	190
Na	127	Ca	196	Cd	255
K	238	Sr	412	Tl	350
Rb	437	Ag	466		
Cs	567	Cu	346		

Attention is called to the fact that if the orbital radius of the outermost electron of a series be taken as the atomic radius instead of the orbital radius of the innermost electron, it will not change the order of values of the specific inductive capacities calculated as above.

Following the discussion of this paper, the question of a Pacific coast organization was taken up. The chairman of the meeting reported that favorable replies had been received from the science instructors at the universities in Washington, Oregon and Utah. It was decided to form an informal organization to be known as the Pacific Physical Society, looking toward the formation of a section or branch of the American Physical Society in the near future.

Ralph S. Minor,
Permanent Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and eighty-fourth regular meeting of the society was held at Columbia University on Saturday, April 29, 1916. The attendance at the two sessions included fifty-one members. President Brown occupied the chair, being relieved by Vice-president E. R. Hedrick. The council announced the election of the following persons to membership in the society: Dr. E. T. Bell, University of Washington; Professor T. R. Eagles, Howard College; Mr. Glenn James, Purdue University; Dr. J. O. Hassler, Chicago, Ill.; Professor G. N. Watson, University College, London; Mr. J. H. Weaver, West Chester, Pa. Six

applications for membership in the society were received. Professor D. R. Curtiss, of Northwestern University, was reelected a member of the editorial committee of the *Transactions*, to serve for three years, and Professor L. P. Eisenhart, of Princeton University, to serve on the same committee in place of Professor Dickson for one year.

The twenty-first summer meeting and eighth colloquium of the society will be held at Harvard University, September 4–9, 1916. Two courses of colloquium lectures, each five in number, will be given by Professor G. C. Evans, of Rice Institute, on "Topics from the theory and applications of functionals, including integral equations," and Professor Oswald Veblen, of Princeton University, on "Analysis situs." The year 1916 marks the twenty-fifth anniversary of the broadening out of the society into a national organization and of the founding of the *Bulletin*. It is proposed to arrange an appropriate celebration of this event at the summer meeting. Some seventy-five of those who were members of the society in the year 1891 have retained their membership through these twenty-five years. It is hoped that the celebration may itself become a notable milestone in the society's history.

Committees were appointed to consider the question of the publication of the Harvard Colloquium Lectures, and to consider in cooperation with committees of other scientific bodies the matter of the classification of technical literature. A committee was also appointed to draw up a list of nominations of officers and other members of the council to be elected at the annual meeting next December.

The following papers were read at this meeting:

Samuel Beatty: "Derivation of the complementary theorem from the Riemann-Roch theorem."

J. F. Ritt: "The resolution into partial fractions of the reciprocal of an entire function of genus zero."

J. F. Ritt: "Linear differential equations of infinite order with constant coefficients."

C. J. Keyser: "Concerning autonomous doctrines and doctrinal functions."

Edward Kasner: "Element transformations of space for which normal congruences of curves are invariant."

J. H. Weaver: "Some extensions of the work of Pappus and Steiner on tangent circles."

J. L. Coolidge: "New definitions for Plücker's numbers."

G. C. Evans: "Integral equations whose kernels satisfy a certain difference equation in variable differences."

Dunham Jackson: "An elementary boundary value problem."

L. P. Eisenhart: "Transformations of conjugate systems."

A. A. Bennett: "An existence theorem for the solution of a type of real mixed difference equation."

A. A. Bennett: "A case of iteration in several variables."

R. W. Brink: "Some integral tests for the convergence and divergence of infinite series."

Glenn James: "A theorem on the non-summability of a certain class of series."

F. J. McMackin: "Some theorems in the theory of summable divergent series."

J. R. Kline: "A definition of sense on plane curves in non-metrical analysis situs."

H. B. Fine: "On approximations to a solution of a system of numerical equations."

B. H. Camp: "Fourier multiple integrals."

G. A. Pfeiffer: "On the conformal mapping of curvilinear angles."

G. C. Evans: "Proof of Green's theorem by approximating polynomials."

A. R. Schweitzer: "On a type of quasi-transitive functional equations."

J. W. Alexander: "Some generalizations of the Jordan theorem."

C. E. Wilder: "Expansion problems of ordinary linear differential equations with auxiliary conditions at several points."

E. V. Huntington: "A simple example of the failure of Duhamel's theorem."

W. F. Osgood: "Note on functions of several complex variables."

F. N. COLE,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 553d regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, March 25, 1916, called to order by President W. P. Hay at 8 P.M., with 40 persons present.

The president called attention to the recent death of Henry Talbott, a member of the society.

Under the heading Brief Notes and Exhibition of Specimens, General Wilcox exhibited lantern slide views of the country along the Mexican border of the United States.

Under the same heading Mr. A. A. Doolittle exhibited a specimen of *Amblystoma punctatum* from the District of Columbia.

Dr. O. P. Hay exhibited a mutilated braincase of an elk which had caused certain persons much difficulty to identify; he also showed a remarkably well preserved skull of an extinct horse.

President Hay exhibited a number of lantern slides of biological interest, chiefly of aquatic animals in the vicinity of Beaufort, North Carolina.

Medical Inspector Ames asked if any member present had positive knowledge as to the ability of camels to swim, or otherwise? This question was discussed by several members, but no positive knowledge was forthcoming. He also inquired as to the possible existence of a South American animal with dorsally placed mammæ.

Following the adjournment of the society several members examined a microscopic preparation of a living embryo of *Filaria bancrofti* obtained by Dr. Lyon from a former inhabitant of British Guiana but for several years resident in the District of Columbia.

The regular program was as follows:

W. P. Hay: "Notes on the Growth of the Loggerhead Turtle," illustrated by lantern slides and chart. Mr. Hay gave an account of two young loggerhead turtles now under observation at the U. S. Fisheries Biological Station at Beaufort, N. C. They are the survivors of a lot of 77 hatched September 9–11, 1912, from eggs obtained from a nest on Bogue Bank about six weeks earlier. When first hatched the average size of the young was: total length 77.3 mm.; length of carapace, 46.2 mm.; weight, 20.1 grams.

At the age of three years the survivors measure 493 and 515 mm., in total length; 343.75 and 365 mm., in length of carapace; and weigh 6,690 and 7,967 grams, respectively. The increase in size and weight has been steady and the measurements, which have been taken twice a year, can be plotted as points on a curve. This curve continued indicates that the maximum size of this species, about 1,000 mm. length of carapace, may possibly be obtained in the tenth or eleventh year, and that sexual maturity is probably reached in the sixth or seventh year. This is considerably more rapid growth than has usually been attributed to animals of this kind.

The paper was discussed by Dr. Shufeldt, Dr. O. P. Hay, Medical Inspector Ames, and Mr. Doolittle.

R. W. Shufeldt: "The Restoration of the Dinosaur, *Podokesaurus holyokensis*." Dr. Shufeldt gave an historical account of a discussion upon the restoration of the dinosaur *Podokesaurus holyokensis* of Talbot, which took place in the autumn of 1915. This discussion was carried on in correspondence and participated in by Drs. Richard S. Lull and Mignon Talbot, Hr. Gerhard Heilmann, and the speaker. Lantern slide illustration and blackboard demonstration were employed to point out what was held to be inconsistencies in the restoration of this animal, as figured in Dr. Lull's "Triassic Life of the Connecticut Valley" (Fig. 31). Drs. Lull and Talbot contend that the pubic element in the matrix of *Podokesaurus holyokensis* occupies the position in relation to the other bones of the skeleton that obtained in life. Dr. Shufeldt and Hr. Heilmann controvert this decision by pointing out that all the bones in the slab containing the remains of this dinosaur are far removed from their normal articulations; and that, if the pubic element were articulated as Dr. Lull has figured it, it would have come, in life, forcibly in contact, anteriorly, with the sternal ribs and been a constant menace to the abdominal viscera in various movements of the animal.

R. E. Coker: "A Biological and Fish Cultural Experiment Station," illustrated by lantern slides. Mr. Coker said that since biologists, at least, are generally familiar with the functions of the Fairport Biological Station in the propagation and study of the fresh-water mussels, particular attention was given to the purposes of that station in experiment work relating to the rearing of fishes.

As in horticulture the problems of the nurseryman and those of the fruit grower are distinct, so in fish-culture, and in fish-cultural experiment work there is the phase of the hatchery with its product of fry and fingerling, and that of the fish farm where it is intended to rear fish to adult size in commercial quantities. The Fairport station is concerned with problems of rearing rather than of hatching. The grower of fish has problems similar to those of the stock farmer or the poultry raiser, while in addition he must take thought for conditions affecting the respiration of fish. He can not always regulate the numbers of fishes in his ponds by direct means, but may have to accomplish this end by proper association of species. It may even be necessary to group together species which are to an extent "incompatible."

The problem of the fish pond has its mechanical, physical, chemical and zoological aspects; more especially, however, it is a problem of appropriate vegetation, promotion of food supply, and proper association of species of fish.

M. W. Lyon, Jr.,
Recording Secretary

SCIENCE

FRIDAY, JUNE 2, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ORGANIZATION OF INDUSTRIAL SCIENTIFIC RESEARCH

IF one attempted to formulate the common belief concerning the origin and development of modern technical industries, it would probably be found that stress would be laid upon financial ability or manufacturing skill on the part of the founders, but if, instead, we were to make a historical survey of the subject I think that we should find that the starting and development of most manufacturing businesses depended upon discoveries and inventions being made by some individual or group of individuals who developed their original discoveries into an industrial process. Indeed, if the localities in which various industries have developed be marked on the map, they will often be found to have far more relation to the accidental location, by birth or otherwise, of individuals, than to any natural advantages possessed by the situation for the particular industry concerned. The metallurgical industries, of course, are situated chiefly near the sources of the ores or of coal, but why should the chief seat of the spinning industry be in Lancashire or of modern optical industry in Jena except that in those places lived the men who developed the processes which are used in the industry? And, moreover, industries are frequently transferred from one locality to another and even from one country to another by the development of new processes, generally by new individuals or groups of workers.

The history of many industries is that they were originated and developed in the first place by some man of genius who was fully acquainted with the practise of the

industry and with such theory as was then known; that his successors failed to keep up with the progress of the industry and with the theory of the cognate sciences; and that sooner or later some other genius working on the subject advanced the available knowledge and again gave a new spurt to the development of that industry in another locality.

Thus, in the early days of the technical industries the development of new processes and methods was often dependent upon some one man, who frequently became the owner of the firm which exploited his discoveries. But with the increasing complexity of industry and the parallel increase in the amount of technical and scientific information necessitating increasing specialization, the work of investigation and development which used to be performed by an individual has been delegated to special departments of the organization, one example of which is the modern industrial research laboratory.

The triumphs which have already been won by these research laboratories are common knowledge. The incandescent lamp industry, for instance, originated in the United States with the carbon lamp, but was nearly lost to the United States when the tungsten filament was developed, only to be rescued from that danger by the research laboratory of the General Electric Company, who fought for the prize in sight and developed first the drawn wire filament and then the nitrogen lamp; and we may be sure that if the theoretical and practical work of the research laboratory of the General Electric Company were not kept up the American manufacturers could by no means rest secure in their industry, as, undoubtedly, later development in electric lighting will come and the industry might be transferred, in part if not completely, to the originators of any improvement. Manufacturing concerns and especially the powerful, well-organized companies who are the leaders of industry in this country, can, of course, retain their leadership for a number of years against more progressive but smaller and less completely organized competitors, but eventually they can ensure their position only by having in their employ men who are competent to keep in touch with and themselves to advance the subject, and the maintenance of a laboratory staffed by such men is a final insurance against eventual loss of the control of its industry by any concern.

There was a time when the chief makers of photographic lenses were the British firms whose owners had been largely instrumental in developing the early theory of lens optics, but that position was lost entirely as a result of the scientific work of the German opticians, led by Ernst Abbe; in a smaller division of optical work, however, the staff of Adam Hilger, Ltd., has been able by its superior knowledge and intensive study of the manufacture of modern spectroscopes to transfer a large portion of the manufacture of such instruments from Germany to England again.

In a recent book review in *Nature* of December 2, page 366, it was pointed out that the rare earth industry has been chiefly concentrated in Germany. The manufacture of gas mantles, discovered by an Austrian, developed an entirely new chemical industry which has been carried on almost completely under German auspices. It seems to be suggested at the present time by some of the leaders of British industry that such specialized chemical operations as the manufacture of compounds of the rare earths can be transferred to Great Britain by the application of superior financial methods or better business foresight or even merely more intense application. I do not believe that any one who is acquainted with

the business men of several countries will believe that the British manufacturer is lacking either in financial capacity or in business foresight or in application, but none of these things by themselves will develop a chemical industry. The only thing that will attract and retain the business is the manufacture and development of new and improved products, and this can be done only by the use of more and better research chemists and physicists than the competitor is willing to employ. In fact, at the present time it seems to be clear that the future of any industry depends upon its being able to command a sufficient supply of knowledge directed towards the improvement of the product and the development of the methods of that industry, and that any failure in this respect may involve eventual failure. While this view of the importance of research work to the industries is now obtaining universal acceptance, I feel that many who assent without hesitation to the value of a research laboratory still take far too low a view of the work which it should perform.

Industrial laboratories may be classified in three general divisions:

1. Works laboratories exerting analytical control over materials or processes.
2. Industrial laboratories working on improvements in product and in processes, tending to lessen cost of production and to introduce new products on the market.
3. Laboratories working on pure theory and on the fundamental sciences associated with the industry.

The first class of laboratory is so obviously necessary that practically all works are so equipped, and frequently each department of a factory maintains its own control laboratory. The second class of laboratories are frequently termed "research" laboratories, and this type has been very largely instrumental in forwarding the introduction of scientific control into industry.

Unfortunately, however, the immediate success of the application of scientific methods to industrial processes has often led the executives of commercial enterprises into the belief that such work along directly practical lines is capable of indefinite extension and in this belief a number of laboratories have been started, some of which, at any rate, have been sources of disappointment in consequence of a failure to grasp the fact that if the whole future of an industry is dependent on the work of the research laboratory, then what is required is not merely an improvement in processes or a cheapening in the cost of manfacture but fundamental developments in the whole subject in which the manufacturing firm is interested; for this purpose it is clear that something very different from the usual works laboratory will be required, and that in order to obtain progress the work of the research laboratory must be directed primarily toward the fundamental theory of the subject. This is a point which seems to be continually overlooked in discussions of industrial scientific research, where much stress is generally laid upon the immediate returns which can be obtained from works laboratories, and upon the advantage of scientific control of the operations; but in every case where the effect of research work has been very marked, that work has been directed not towards the superficial processes of industry but toward the fundamental and underlying theory of the subject. From Abbe's work on lenses, and Abbe and Schott's work on glasses, to the work of the research laboratory of the General Electric Company on the residual gases in lamp vacua, which resulted in the production of the nitrogen tungsten lamp and the Coolidge X-ray tube, this will be seen to be

true, and we must consequently agree that for industries to retain their position and make progress they must earnestly devote time and money to the investigation of the fundamental theory underlying the subject in which they are interested.

Research work of this fundamental kind involves a laboratory very different from the usual works laboratory, and also investigators of a different type from those employed in a purely industrial laboratory. It means a large, elaborately equipped, and heavily staffed laboratory engaged largely on work which for many years will be unremunerative and which, for a considerable time after its foundation, will obtain no results at all which can be applied by the manufacturer.

The value of a research laboratory is essentially cumulative; in the beginning it may be of service as bringing a new point of view to bear on many problems; later, accumulated information will be more and more available; but most men acquainted with industrial research work consider that five years is the earliest date at which any considerable results can be expected from a newly established research laboratory and that the development of really new material in considerable quantities so that it will have an effect upon the industry as a whole can not be looked for in less than ten years' consecutive work. This does not mean that a laboratory is useless during the initial period, since it will be of considerable service in many other directions than in that of its main work on the fundamental problems, but when this main line of research begins to bear fruit it will absorb the energies both of the laboratory and of the factory.

It is often suggested that the problem of the organization of scientific industrial research is really the problem of obtaining satisfactory cooperation between the manufacturers and the universities, possibly with small research laboratories in the factories themselves acting as intermediaries. Various schemes have been suggested for enabling the universities to carry out research work of value to the manufacturers, but if it is believed that the work chiefly required for the development and maintenance of industry deals with the fundamental theory of the subject, it will be seen that this can not possibly be carried on to any large extent in collaboration with a university; it requires a continuity of application by the same investigators over long periods with special apparatus and with the development of special methods which can not be expected from any university. This necessity for continuous work along the same line is, indeed, the greatest difficulty in making use of the universities for industrial research. The conditions of a university laboratory necessarily make it almost impossible to obtain the continuous application to one problem required for success in industrial research and, indeed, in the interests of teaching, which is the primary business of a university, such devotion to one problem is undesirable, as tending to one-sidedness.

There are also difficulties in obtaining the cooperation of manufacturers with universities and in the application of university work to industry, which I see no hope whatever of overcoming; the universities do not understand the requirements of the manufacturer and the manufacturer distrusts, because he does not understand, the language of the professor. Moreover, it is quite essential that any investigator who has worked out a new process or material should be able to apply his work on a semi-manufacturing scale so that it can be transferred to the factory by skilled men who have already met the general difficulties which would be encountered in factory application. This development on a semi-

manufacturing scale is, indeed, one of the most difficult parts of a research resulting in a new product, and the importance of it is shown by the fact that all the large industrial research laboratories, however concerned they may be with the theory of the subject, have, as parts of the laboratory and under the direction of the research staff, experimental manufacturing plants which duplicate many of the processes employed in the factory itself.

All these arguments tend to show that an industrial research laboratory must necessarily be of considerable size, but this requirement is much accentuated by another consideration altogether.

Except in a few branches of pure science small research laboratories are relatively inefficient, in the technical sense of the term, that is, they require more time and cost more money for the solution of a given problem.

When considering this subject it is necessary first to dismiss from the mind completely the idea that any appreciable number of research laboratories can be staffed by geniuses. If a genius can be obtained for a given industrial research, that is, of course, an overwhelming advantage which may outweigh any disadvantages, but we have no right to assume that we can obtain geniuses; all we have a right to assume is that we can obtain at a fair rate of recompense, well trained, average men having a taste for research and a certain ability for investigation. The problem, then, is how can we obtain the greatest yield from a given number of men in a given time? Investigation of the subject shows that the yield per man increases very greatly as the number of men who can cooperate together is increased. The problems of industrial research are not often of the type which can be best tackled by one or two individual thinkers, and they rarely involve directly abstract points of theory, but they continually involve difficult technical and mechanical operations, and most of the delays in research work arise because the workers engaged on the subject do not know how to do some specific operation. In my own experience, I have seen a good man stick for six months in an investigation because he did not know and could not find out how to measure a conductivity with a precision higher than one part in a thousand, a point which was finally found to be perfectly well known to several scientific workers in the country. Again, it took another good man three months to learn how to cut a special form of section, but having learned the trick he can now cut sections for all the workers in the laboratory with no delay whatever.

In this connection the advantage of permanent set-ups of apparatus may be pointed out. Among a large number of chemists some one will continually be wanting to photograph an ultra-violet absorption spectrum or to take a photomicrograph, and if the apparatus for these purposes is erected and in charge of a competent man who understands its use, the work can be done without any delay at all, the photography of the absorption spectrum of an organic liquid by a man who is used to the work taking only an hour; but if this point is vital to the research and the chemist is quite unacquainted with the technique of the subject and has no apparatus available, it may easily take him six months to find out what has been done on absorption spectra, to buy and erect the apparatus, and become skilled in its working.

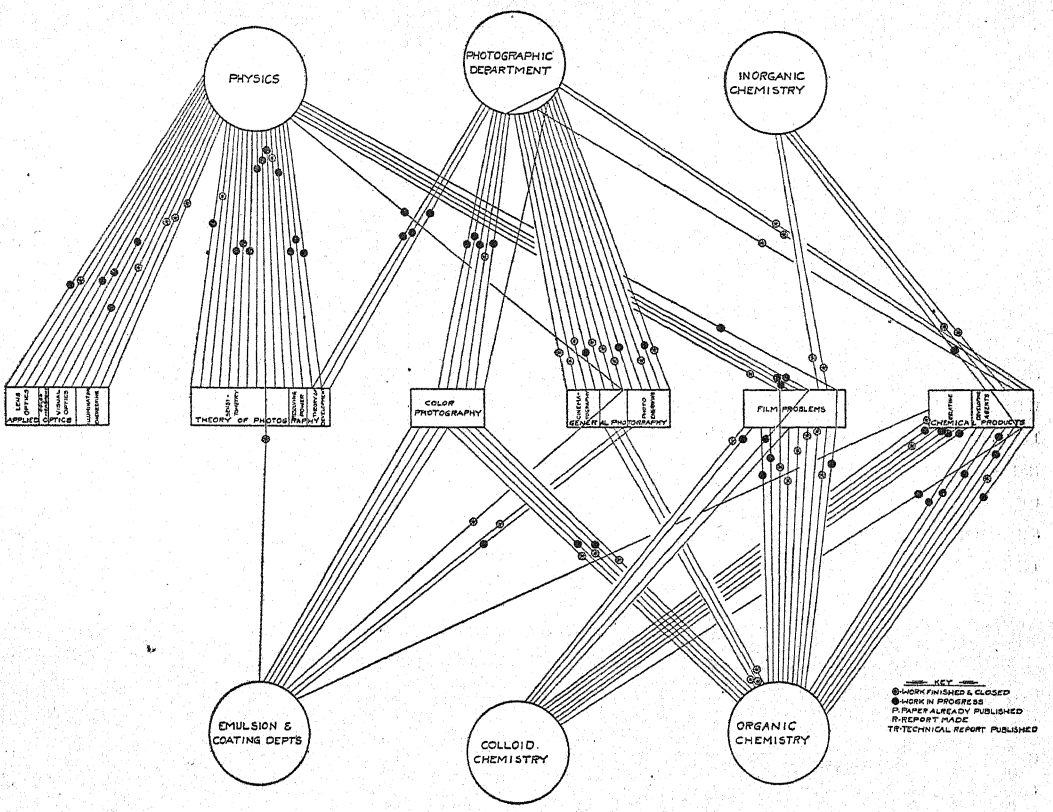
From these causes, then, the efficiency of a laboratory increases very greatly with its size provided that there are good arrangements for cooperation between the different workers of the laboratory so that they are kept informed of each other's problems.

When considering the efficiency of research work it must be remembered that the efficiency is necessarily extremely low since it is very rarely possible to arrange any research so that it will directly proceed to the end required.

It is the common opinion of those who have to deal with the organization of research that only a small percentage of all the investigations started are likely to be successful, the great majority being either dropped before they come to an end, or being carried through, and filled simply as records, without any results having been obtained which would justify the expense of the investigation; that is to say, industrial research is justified only by the great value of the successful attempts, and these must bear the burden of a great number of unsuccessful attempts which may have been quite as costly as the successful ones themselves. The object of organization is to attempt to reduce the proportion of unsuccessful investigations which will be undertaken, as has already been shown. This can be done by increasing the size of the laboratory, by increasing the specialization of the workers, and especially by increasing cooperation between workers in different fields.

Naturally, the most important step which could be taken to increase the efficiency of industrial research would be to increase the likelihood of correct choice of a promising investigation, but, unfortunately, very little can be done in this direction. Those with the most experience in research work are all agreed that it is almost impossible to say whether a given investigation will prove remunerative or not. The only general conclusion that can be drawn is that the deeper a given investigation goes towards the fundamentals of the problem the more likelihood there is that the results will be of value, and the more superficial an investigation is, even although it appears more promising at first sight, the less likelihood there is that it will finally prove of real worth, so that the choice of investigations must necessarily be made largely at random and will be influenced to a great extent by the ideas of the scientific workers themselves; if any worker has a desire to take up any particular line of work, provided that it is associated with the general trend of work in the laboratory, it is usually wise to let him do so, but the expedition with which a decision can be reached as to the probable value of the investigation after it has been started is very greatly enhanced by complete cooperation of workers in the different branches of science in consultation on the problem.

At this point it might be well to discuss the organization of a large research laboratory. Such a laboratory should be established in charge of a director who has had some actual manufacturing experience in the work processes but at the same time he must have a considerable sympathy with purely scientific work and an interest in the advancement of scientific theory. *Both* these qualifications are desirable, but if such a director combining the two can not be found, then a man of full scientific training should be chosen and put into a position of responsibility in the manufacturing side of the industry until he has become fully acquainted with the technique of the industry. It is most inadvisable to take a man from the industry who has not had a full scientific training, including advanced research work in academic problems, since he will generally be lacking in sufficient knowledge of and sympathy with the more academic investigations of which he will be in charge and if the two necessary qualifications can not be found united in one man, it will be necessary to take a man with the scientific qualifications and give him the



practical training, which is just as essential for the director of a laboratory as scientific knowledge.

These necessary qualifications in the director are reflected in the division of the laboratory itself into manufacturing and scientific sections, since the manufacturing section should be able to carry out on a small scale all the chief manufacturing operations so that any investigations made in the laboratory can be carried through to the practical works scale without interfering with the production departments. In the research laboratory of the Eastman Kodak Company the manufacturing department includes emulsion-making and plate, film and paper coating departments, the capacity being very considerable, the plate department being able to make 300 dozen 8×10 in. plates a day. These departments are used not only for systematic experiments on emulsion suitable for various purposes, such as different kinds of plate emulsion, color sensitive emulsions, especially for color photography, and experimental printing papers, but they are further used to make on a small scale products which are required for special purposes in very small quantities, such as special plates required by astronomers or spectroscopists or special film required for experimental purposes by those working on color photography or attempting to develop other photographic processes. Requests for such special materials are received by every large manufacturing company, and the execution of the orders in the production departments frequently involves much delay and loss, whereas the manufacturing section of the laboratory can carry out the

work with a full understanding of the use to which the materials are to be put and can often materially assist the purchaser in working out his idea. Cooperation of this kind between the general public and the laboratory can not but be of advantage to both parties.

The manufacturing departments should be in charge of skilled foremen who have had previous experience in the works and be run in exactly the same way as the production departments themselves, being under the general supervision of the director of the laboratory and of any assistants that it may be necessary for him to employ. The foremen of the departments should, however, cooperate very fully with the scientific departments.

There is always some difficulty in a laboratory in getting the scientific departments to make full use of the special knowledge of the manufacturing division and at the same time to realize the practical difficulties which occur in works processes, but this difficulty can be overcome much better in the case of the manufacturing division of the laboratory than it could if an outside production department were involved without the laboratory division acting as intermediary.

The scientific division of the laboratory should be divided into departments dealing with the special subjects, but every care should be taken that these departments do not become at all isolated from each other and that they cooperate with each other in the most complete way on the solution of the problems on which the laboratory is engaged. In order to insure this the main lines of work under investigation may be suitably discussed at a morning conference at the beginning of the day's work, one day of the week being assigned to each subject. The laboratory organization will then resolve itself into a number of different departments engaged in dealing with a number of different lines of work, and the total work of the laboratory during the year may be suitably represented, as is shown by the chart (see figure), which is that actually devised for the research laboratory of the Eastman Kodak Company.

The departments of the laboratory are represented as circles on the outside of the chart, the main divisions in which problems group themselves being represented by the rectangles, subdivided in some instances, occupying the middle of the chart. Each of these rectangles will correspond to a morning conference; thus, a conference will be held on general photography, at which there will be present members of the photographic department, the physics department, the department of organic chemistry and the emulsion and coating or manufacturing departments. There will be present at the conference, in fact, every scientific worker of the laboratory, whatever his rank, who is directly engaged on the subjects which are included under the head of general photography, and in some cases, or on special occasions, members of the staff of the company external to the laboratory may be invited to these conferences, although as a general rule in the case of a large company it will not be possible for them to be regularly present. All the main lines of investigation should be laid down at these conferences and the progress from week to week carefully discussed. This procedure will enable a great saving in time to be made, since it will avoid the loss of time which continually occurs in laboratories from the wrong man doing a specific piece of work; and the economy can be much increased by suitable arrangement of the building and equipment itself.

The building should be so arranged that all the laboratories are open to everybody in the scientific departments but that in

each laboratory involving special classes of apparatus there are specialists continually working who are available for consultation and assistance to all other workers in the laboratory. In this way single operations which become necessary in the course of an investigation may frequently be transferred from the man who has carried on the main line of work on the subject to some other specialist in the laboratory. In the Kodak laboratory, for instance, electrical measurements, photometric measurements, spectrophotography, lens optics, photographic sensitometry, work involving dyestuffs, and all strictly photographic operations, such as copying, lantern-slide making, printing and enlarging, making up developers, etc., are in the hands of specialists, and whenever any of these operations become necessary in the course of an investigation, the conference directs that they be carried out by the specialist on the subject. In this way an organic chemist, for instance, will have the absorption curve of his products measured not by an instrument in the organic laboratory but by the physics department, while the preparation of photographs, lantern slides and prints which are often involved in publication are carried on by the photographic department and not by the man who did the work, these arrangements relieving specialists in one subject from having to acquire technical skill in another. It is in such complete cooperation that the greatest economy in scientific investigation is to be found.

It must be remembered that such specialization as this is not at all suitable for use in a university, where the object is the broadening and education of the students; it is one of the many differences between research work in a university and in a set research laboratory, whether it be industrial or not, that in a university the primary object is the training of the worker, while in the research laboratory the primary object is the carrying out of the investigation.

The best utilization of the results obtained in an industrial research laboratory is only second in importance to the organization required to obtain them. All results of general scientific interest and importance should undoubtedly be published both in the public interest, and also because only by such publication can the interest of the laboratory staff in pure science be maintained. It is doubtful if the importance of maintaining the full interest in theoretical science of a laboratory staff has been fully realized. When the men come to the laboratory they are usually interested chiefly in the progress of pure science, but they rapidly become absorbed in the special problems presented to them and, without definite effort on the part of those responsible for the direction of the laboratory, there is great danger that they will not keep up to date in what is being done by other workers in their own and allied fields. Their interest can be stimulated by journal meetings and scientific conferences, but the greatest stimulation is afforded by the requirement that they themselves publish in the usual scientific journals the scientific results which they may obtain. Another reason for publication is that when a piece of work is written up for publication the necessity for finishing loose ends becomes manifest and that work which is published is therefore more likely to be properly completed.

With some laboratories publication is rendered difficult by the industrial organization; while nominally manufacturing companies are usually willing that results of scientific interest should be published, the organization of the company frequently requires that they be passed on by the heads of several departments, such as the

sales, patent, advertising, manufacturing, and so on, and the heads of these departments, possibly not understanding the subject and being afraid of passing material which might prove detrimental, frequently err very much in the direction of withholding entirely harmless information from lack of sufficient knowledge. It is much more satisfactory, if possible, for one responsible executive to pass on all matter submitted for publication, and this will inevitably result in a much more liberal policy than where the responsibility is delegated to a number of representatives of different departments of the company.

In addition to these scientific papers special technical reports for the information of the staff of the company itself should be circulated by the laboratory, and in the case of the Kodak laboratory an abstract bulletin is published monthly giving information as to the more important papers appearing in the technical journals associated with the photographic industry and also of all photographic patents. It is often advisable, also, to prepare special bulletins dealing with the application of scientific investigations, which have already been published, to the special needs and interests of the company.

Since the evidence points, therefore, to the establishment of really large research laboratories as the most economical and efficient way of increasing the application of science in industrial work the question arises as to how these large laboratories are to be supported. In the United States the great manufacturing corporations, who can afford the necessary capital and expenditure for maintenance, and are willing to wait for the results, have already undertaken the establishment of a number of large research laboratories. Such concerns as United States Steel, General Electric Company, United States Rubber, du Pont de Nemours, and many others are supporting large and adequately equipped research laboratories whose staffs are engaged in work on the fundamental theory of the industries in which they are interested, and undoubtedly more and more such laboratories will be established in the course of the struggle for increased industry which the United States is preparing to wage. There are a large number, however, of smaller firms who can not afford the great expenditures involved but who are anxious to benefit by the application of science to their work, and it seems that the only solution to the problem of providing for such firms is in the direction either of cooperative laboratories serving the whole industry, as has already been done in the case of the National Canners' Association and the National Paint Association, and no doubt in some others, or in the erection of national laboratories devoted to special subjects connected with industry and corresponding to such institutions dealing with special branches of pure science as the geophysical laboratory of the Carnegie Institution. Schemes for industrial scholarships tenable at universities do not meet the case at all, since work done under such arrangements must necessarily be limited in respect to time and directed towards a definite practical end rather than towards the general acquisition of knowledge connected with the underlying principles on which an industry rests. In the same way consulting laboratories, like industrial scholarships, are interested in the development of results for immediate practical application, and both these methods of work are substitutes for the practical industrial laboratories belonging to my second general division rather than for the large laboratories here discussed.

In England the coordination of industry has not proceeded as in the United States

and there are very few corporations who would be willing to maintain a large, fully equipped research laboratory of the type discussed, although a few such laboratories are well known to be in existence, but British industry has been brought very much together during the past eighteen months and the organization of industry is already a familiar phrase. Why, then, should England not establish a National Industrial Research Laboratory to assist all British manufacturers and to develop the theory underlying the great fundamental industries on which British work depends? Such a laboratory could take the theory from the universities, or where the theory was lacking, develop it and apply it to the separate industries, working out the results on a semi-manufacturing scale and finally passing it on to the manufacturer. It may be of interest to glance at the possible size and scope of such an organization and I have attempted to formulate a scheme which will represent the minimum which would be required.

A laboratory on the smallest scale adequate to British industry would, at the beginning, require a staff of about two thousand men, one thousand of them scientifically trained and the other thousand assistants and workmen. It should have about three or four hundred men of the rank of professor or assistant professor in the universities or of works manager or assistant manager or chief chemist in the factory. It would require land and buildings costing about $3,000,000 and its annual upkeep with allowance for expansion would be about $4,000,000.

Vast as these figures are, they are infinitesimal compared with the value of the industries whom they would serve. They represent a charge of less than one per cent. and probably not more than one fifth per cent. of the net profits of British industry; moreover, after the initial period has been paid for such a laboratory might be self-supporting and might, indeed, finally, make a very handsome profit on the original investment.

Suppose that such a laboratory patented all inventions and licensed manufacturers to use them, then, it is not too much to expect that after the first five or six years it would be paying for itself, and that five years later it would be able to establish a great many subsidiary institutions from its profits; at any rate, such a vast laboratory would produce far more results at lower cost than would result from any other expenditure of a comparable sum of money on industrial research by the British industries.

I believe, however, that within the lifetime of most, if not all, of us we shall see such extensions of industrial research as will make all that we now have in mind seem insignificant, and it is because I believe so strongly in the importance of the subject that I have endeavored to collect some impressions on the subject and to present them in this paper.

C. E. KENNETH MEES

RESEARCH LABORATORY,
EASTMAN KODAK COMPANY,
ROCHESTER, N. Y.,
February 10, 1916

BENJAMIN FRANKLIN AND ERASMUS DARWIN: WITH SOME UNPUBLISHED CORRESPONDENCE[1]

IT is not generally known that Benjamin Franklin and Erasmus Darwin were correspondents and personal friends. They first met, as far as can be learned, some time during Franklin's second mission to England, between 1764 and 1775, and, attracted to each other by their common scientific interests, a

[1] I wish to acknowledge my deep thanks to Mr. I. Minis Hays, secretary of the American Philosophical Society, for his kind permission to transcribe and publish the correspondence here given.

friendship grew up between them which lasted to the end of Franklin's life. This friendship, after the fashion of the time, found expression chiefly in long letters discussing the scientific views and questions of the day, often accompanied by their own observations or reflections. Darwin, who it should be remembered was Franklin's junior by twenty-five years, was plainly proud of the regard of his famous contemporary, and this feeling is unmistakably reflected in his letters.

In the wonderful collection of Frankliniana[2] in the library of the American Philosophical Society in Philadelphia, there are three autograph letters from Darwin to Franklin, two of them still unpublished. These letters are of great interest for the glimpse they afford into the thoughts and hopes and problems that occupied two such lights of science as these men in the latter half of the eighteenth century.

The earliest of the three letters, and one of the two still unpublished, is dated Lichfield, July 18, [17]72, and is addressed: "Dr. Benjamin Franklin, Craven Street, London." It is remarkable chiefly for one sentence near the end, which contains the amazing information that even as far back as that, someone was puzzling over the idea of making a phonograph. "I have heard," writes Dr. Darwin, "of somebody that attempted to make a speaking machine, pray was there any Truth in any such Reports?"

The rest of the letter is not especially important, and is only interesting as showing the diversity of subjects discussed. Darwin first describes an experiment he performed with "unmix'd air, that rose from the muddy bottom" of a pond, and of which he took home a sample in a bladder and tested it with a lighted candle to see if it would catch fire; which it did not. Then he goes on to say.

I shall be glad at your Leizure of any observations on the Alphabet, & particularly on the number and Formation of vowels, as these are more intricate, than the other Letters.

He then devotes several paragraphs to a discussion of consonant sounds in various dialects as among the Welsh, Northumberland people and others. The letter closes as follows:

I am Sr. with all Respect your obliged & obedt. Servant

E. Darwin

Lichfield, Staffordshire.

I would return you Dr. Priestley's Pamphlet by the Coach but I suppose it is to be purchased at the Booksellers. My friend Mr. Day who saw you at Lichfield intends himself the Pleasure calling of you in London.

A second letter in the collection is a one-page quarto from Darwin to Franklin, dated Lichfield, Jan. 24, 1774. This is the most valuable of all the Darwin–Franklin correspondence extant; it shows Franklin's close relation to the Royal Society of London and also that he read papers before that body for up-country friends. This letter has already been published,[3] but as it has such great general interest, and is so short, it seems worthy of being made more widely known.

Dear Sir,

I have inclosed a medico-philosophical paper which I should take it as a Favour if you will communicate to the royal Society, if you think it worthy a place in their Volume, otherwise must desire you to return it to the Writer.

I have another very curious paper containing Experiments on the Colours seen in the closed Eye after having gazed some time on luminous objects, which is not quite transcribed, but which I will also send you, if you think it is likely to be acceptable to the Society at this Time, but will otherwise let it lie by me another year. I hope you continue to enjoy [. . . torn . . .] Health & that I shall sometime again have the pleasure of seeing you in Staffordshire, & am, dear Sr.

Your affectionate Friend,

Eras. Darwin

N. B. If Dr. Franklin is not in England, I hope the person intrusted to read his letters will return the inclosed papers to Dr. Darwin at Lichfield,

[2] The collection contains 16,678 pieces, or 78 per cent. of all the Franklin papers extant. See preface to "Calendar of the Papers of Benjamin Franklin in the Library of the American Philosophical Society," edited by I. Minis Hays. Philadelphia, 1908.

[3] Jared Sparks' edition of the works of Benjamin Franklin, Vol. VI., page 410, where it is printed with some slight errors in transcription.

Staffordshire, which will be gratefully acknowledged.

The last letter in the collection, also unpublished, is a three-page quarto dated Derby, May 29, 1787. It is addressed simply: "Dr. Franklin, America," and opens in the grandiloquent style of the time, as follows:

Dear Sir,

Whilst I am writing to a Philosopher & a Friend, I can scarcely forget that I am also writing to the greatest Statesman of the present, or perhaps of any century. . . .

I can with difficulty descend to plain prose after these sublime ideas, to thank you for your kindness to my son Robt. Darwin[4] in France, & to converse with you about what may arise in philosophy, which I know will make the most agreeable part of my letter to you.

Then he speaks at length of some electrical experiments performed by a Mr. Bennet, "a Curate in my neighbourhood," who "has found out a method of doubling the smallest conceivable quantity of either plus or minus electricity, till it becomes perceptible to a common electrometer, or increases to a spark."

The end of the letter is interesting and worth quoting in full since it gives the history of the first translation of Linnæus's botanical writings into English.

In respect to other philosophical news, I have just heard from Mr. Wedgewood that Mr. Herschel has discover'd 3 Volcanoes in the Moon now burning.

Since I had the pleasure of seeing you, I have removed from Lichfield to Derby & have superintended a publication of a translation of the botanical works of Linnæus, viz. The System of Vegetables in two volumes 8vo. & the Genera or Families of Plants in 2 vol, 8vo. also.—I did this with design to propogate the knowledge of Botany. They are sold to the booksellers at 14/ the System of Vegetables—the Genera will be finished in a month, & will be sold to the booksellers at 12/ I believe,—but as we are to pay for advertizing & carriage, I expect we shall not clear more than 10/ on each set. If the work had been finished I should have sent you it by the favor of Mr. Nichlin, who is so kind as to take the care of this letter. If I thought 20 sets of each were likely to be sold I would send them at 10/ a set of each, that is 20/ for the four volumes. And indeed would now have sent them by Mr. Nichlin, had the whole been ready, as I think they would not be worth reprinting in America, & perhaps 20 sets would be as many as could find purchasers.

A Line from you at your leizure, only to acquaint me that you continue to possess a tollerable share of health would be very acceptable to, dear Sr. with true esteem

Your most obed. ser.

E. DARWIN

[4] The father of Charles Darwin.

L. HUSSAKOF

AMERICAN MUSEUM OF NATURAL HISTORY

SVEN MAGNUS GRONBERGER

SVEN MAGNUS GRONBERGER, of the library staff of the Smithsonian Institution, died at Georgetown University Hospital, Washington, on April 24, after an illness of about three weeks. He leaves two older brothers and a nephew, resident in Stockholm, Sweden; his estate he bequeathed to this nephew.

Mr. Gronberger, who was a native of Sweden, born August 19, 1866, was graduated in 1884 from the gymnasium of Norrköping, an historic old city on the Baltic about seventy-five miles south of Stockholm. In 1886, after visiting France and England, he went to New York City, where he studied law and in 1907 came to Washington. As a student of natural science he was preparing for the degree of Doctor of Philosophy at George Washington University, with topics zoology and geology, in which subjects he had published several papers, and articles in *Forest and Stream*. He was an accomplished linguist, knowing perfectly French (which was his home language as a member of the nobility of Sweden, his mother being a countess) and the Scandinavian tongues, including some Icelandic, and being versed also in English, German, Italian and other European languages and literatures, besides Latin and Greek. For a number of years Mr. Gronberger made a special study of zoological parks as factors in the popularization of natural science, especially in connection with the Bronx Zoological Park of New York and the National Zoological Park at Washington. He was a member of the Biological

Society of Washington, the Anthropological Society of Washington, the American Ornithological Union, the Audubon Society, and the Writers Club of Washington.

Mr. Gronberger wrote an exhaustive monograph on the "Palearctic Birds of Greenland," the first thorough study attempted of the subject, being a review of the occurrence of European and Asiatic species in Greenland from the middle of the eighteenth century to the present time, publication of which is in charge of the United States National Museum. He published a study of "Birds near Washington," in *Forest and Stream*. A paper by him on "The Origin of the Goths" deals with the Gothic migration from Scandza, or Scandinavia, as described by Jordanes and the corrobating evidence of a celebrated runic inscription in Sweden; probably to be brought out in Stockholm. Publication of a recent study of the Batrachia Salientia or Anura of the District of Columbia is in charge of the National Museum. He left also a life of the religious mystic, "Saint Bridget [Brigitt] of Sweden," based on the best historical sources available. An address by Mr. Gronberger on "Modern Swedish Literature" will be published by the Writers Club of Washington, with a biographical sketch and portrait of the author.

F. E. Fowle

SCIENTIFIC NOTES AND NEWS

Dr. Edward S. Morse has been reelected president of the Boston Society of Natural History.

Under the retiring clause in the faculty regulations of Stanford University, Dr. David Starr Jordan has, as has already been noted in Science, been made chancellor emeritus; Dr. Oliver Peebles Jenkins has been made professor emeritus of physiology and histology, and Dr. Lillian Jane Martin, professor emeritus of psychology.

Sir T. Clifford Allbutt, regius professor of physics at the University of Cambridge, has been nominated by the council to be president of the British Medical Association. On account of the war the annual meeting at Cambridge will be postponed, but the statutory general meeting will be held in London, on July 28.

We regret to learn that Professor Elie Metchnikoff, head of the Pasteur Institute at Paris, France, who has been ill since January with heart trouble has become worse.

Professor Wm. Bullock Clark, head of the department of geology at the Johns Hopkins University, has been appointed by the Chamber of Commerce of the United States a member of a committee of five to discuss with the representatives of organized labor a modification of the anti-trust laws by which cooperative agreements under the regulation of the Federal Trade Commission might be allowed in those industries dealing with the primary natural resources.

At the annual dinner of the Geological Journal Club, of Columbia University, on May 17, the students and members of the departmental faculty presented to Professor Amadeus W. Grabau a copy of Suess's "The Face of the Earth," in commemoration of the completion of fifteen years of active service as a teacher in Columbia University and as a philosophical student of geology. Mr. S. H. Knight, fellow in paleontology, made the presentation. Professor Grabau also received an anonymous gift of $150 from a former student for the furtherance of his research in stratigraphy and paleontology.

Professor August von Wassermann, head of the Royal Institute for Infectious Diseases at Berlin, will become director of the Institute for Experimental Therapy at Frankfort, in succession to the late Professor Paul Ehrlich.

Dr. F. F. Martinez, who has published several works on tropical medicine, has been appointed director of the newly organized Institute of Tropical Medicine at Granada.

Dr. William Palmer Lucas, San Francisco, professor of pediatrics in the University of California Medical School, has gone to Europe to aid in the organization of children's work for the American Commission for Relief in Belgium.

PROFESSOR EDWARD W. BERRY, of the geological department of the Johns Hopkins University, will do work in Mississippi and Texas for the U. S. Geological Survey during the coming summer.

THE British Science Guild held its annual meeting on May 17, when an address was given by the Hon. Andrew Fisher, high commissioner for the commonwealth of Australia, on "The Establishment of a National Institute of Science and Industry in Australia."

WITH the aid of a grant from the National Geographic Society Dr. Robert F. Griggs, of the Ohio State University, will continue this summer his researches in the Katmai District of Alaska. He hopes to explore the hitherto unvisited volcanoes of the district but will devote his attention primarily to a study of the revegetation of the region devastated by the great eruption of Mt. Katmai in 1912.

ABNER HOWARD POWERS, professor of surgery in the school of medicine of Boston University, died on May 13, aged sixty years, from injuries received in an automobile collision.

DR. JAMES ROBERT JONES, professor of theory and practise of medicine in Manitoba Medical College, Winnipeg, has died at the age of sixty-seven years.

DR. M. STRAUB, professor of ophthalmology at the University of Amsterdam, has died, aged fifty-seven years.

PROFESSOR H. P. WIJSMAN, who held the chair of toxicology at Leyden, died on March 19.

M. JULES GOSSELET, professor of geology at Lille from 1865 to 1902, died at Lille on March 20, aged eighty-four years.

THE death is announced of E. Jungfleisch, professor of organic chemistry at the College of France, with a chair also at the Academy of Arts and Trades.

THE Indiana Academy of Science is holding its spring meeting at Valparaiso, on June 1, 2 and 3, as guests of Valparaiso University and the local members.

THE Maryland Geological Survey will have a number of parties in the field during the summer gathering data for systematic reports on the Silurian and Carboniferous formations, economic reports on the coals and fire clays, and on the underground waters. The following instructors and graduate students of the Geological Department will be engaged in this work: Professor Swartz and Dr. H. Bassler will be in the Silurian and Carboniferous region of western Maryland. G. M. Hall will be at work gathering materials for a report on the fire clays of the state. W. A. Baker will gather data regarding the equipment of the coal-operating companies for a report on the Coals of Maryland. J. P. D. Hull will spend part of the summer mapping the soils of Howard County and the balance in working on the geology of the Piedmont area of the same county. H. Insley will work on the Piedmont area of Harford County and on the underground waters of the northeastern tier of Piedmont counties. D. G. Thompson will work on the underground waters of portions of central and western Maryland.

THE Biological Station maintained by the University of Michigan at Douglas Lake, Michigan, will be opened for its eighth season from July 3 to August 25. The laboratory is provided with all the apparatus usually found at summer stations, but possesses also a considerable amount of equipment not ordinarily found elsewhere. The purpose of the institution is to provide instruction and facilities for research in animal and plant ecology under conditions as nearly natural as possible. For the coming session the zoological part of the program includes studies on the ecological relations of the aquatic vertebrate and invertebrate fauna, insects, birds and parasites, whereas the botanical courses will deal with forest botany, plant anatomy, general systematics and ecology. In addition to these more or less formal courses, students may elect special work adjusted to their individual needs. Independent investigators and others who desire to make use of the station are invited to communicate with the director at the University of Michigan.

WE are requested by the Surgeon-General of the Navy to print the following statement:

"Among the various items of increase in national preparedness which it is hoped will be afforded by the present session of Congress is that authorizing an appropriate increase in the personnel of the military services. One item of interest to the medical profession of the country is that calling for an increase in the medical corps of the Navy from its present strength of 347 to approximately 500. The openings at present afforded young graduates in medicine for entering the medical corps of the Navy will be materially increased in prospects and rewards, therefore, if such an increase is provided. An examination will be held on June 19 next, for appointment in the medical corps to vacancies already existing. A candidate for appointment must be between twenty-one and thirty years of age, a graduate of a reputable school of medicine, and must apply for permission to appear before an examining board. These boards are convened at various places over the country, and assignments to such boards are arranged to suit the convenience of the candidate. Duty in the medical corps of the navy is one that affords plenty of rewards to the ambitious worker, as well as attractions of a varied nature in personal and professional work. Pay begins at the rate of $2,000 per annum, with ample allowances, and promotion and increase in pay and allowances follow every few years. It is hoped that the young men of the United States will take advantage of this attitude of the nation, now on the threshold of expansion in national ideals of preparedness, and find in the service of their country an outlet for their future life work. For detailed information as regards the coming examination on June 19, 1916, applicants should address the Surgeon-General, U. S. Navy, Navy Department, Washington, D. C."

RADIUM, uranium and vanadium are closely connected in occurrence in the principal fields, Colorado and Utah, but in 1915, although the European war caused a great slump in the production of ores of radium and uranium, it caused a considerable increase in the production of ores of vanadium. According to reports for 1915 received by the United States Geological Survey and compiled by Frank L. Hess the output was 23.4 tons of uranium oxide and 6 grams of radium contained in the carnotite ores produced, and 635 tons of vanadium contained in the carnotite ores shipped and in the chemical concentrates from the roscoelite ores. In 1914 the ores produced contained 87.2 tons uranium oxide, 22.3 grams radium, and 435 tons vanadium. The United States has much the largest known radium-bearing deposits of the world, but the market for radium is mostly in Europe, for, though Americans like to feel that they are sufficiently progressive to take hold of and use to the full new discoveries, inventions and processes, yet the European municipalities and hospitals have been buying and utilizing most of the radium produced. When the war began, therefore, causing European money to flow into other channels the demand for radium fell off so greatly that there was practically no market for radium or uranium ores in the early part of 1915, and very little market during any part of the year. Mining of carnotite ores, except by the National Radium Institute (Inc.) under the supervision of and in cooperation with the Bureau of Mines, and except for such work as was necessary for assessment work to hold claims, was nearly stopped. The institute mined nearly the 1,000 tons of ore contracted for from the Crucible Steel Mining & Milling Co.'s claims in Long Park, Montrose County, Colo., and obtained 70 tons of concentrates, carrying about 3 per cent. of uranium oxide, by concentrating material carrying 0.7 per cent., which had been thrown on the dumps. The institute fully accomplished its purpose to work out a practical process of producing radium at a cost much below the market price of the element and crystallized out radium salts containing 6 grams of the element. It delivered during the year 3.006 grams of radium (element) at a cost of $37,599 per gram. Near the close of the year 1.1 grams of radium (element) was contracted for by a private company for $132,000, or $120,000 a gram. This comparison shows the great success of the work of the Bureau of

Mines. Its ore concentration method seems to have also been highly successful. After mining its quota of ore from the Crucible Steel Mining & Milling Co.'s property, the institute came into the market as a purchaser of ore. In the later half of the year Dr. W. A. Schlesinger and associates established a radium reduction plant in Denver. They acquired an interest in the Copper Prince claims, from which ore was mined, and bought a further quantity. Ore carrying about 5,000 pounds of uranium oxide, containing about 640 milligrams of radium, was treated during the year. The Carnotite Reduction Co., made up of Dr. H. N. McCoy of the University of Chicago and associates, purchased from Galloway and Belisle a quantity of ore which had been stored in Placerville, Colo., and the radium will be extracted in Chicago. The company will mine ore from claims it has bought. The Standard Chemical Co. did no work on its claims except that required by law, but in this work produced and shipped a quantity of ore from its properties in Colorado and Utah, and purchased, it is stated, a considerable number of claims. It was reported in December that the company had produced a total of 14 grams of radium (elemental) and that its ore had averaged 1.7 per cent. uranium oxide. Probably between 4 and 5 grams of this quantity were produced during 1915. The production of radium salts in this country during the year was probably nearly 11 grams.

MR. BARNUM BROWN returned to the American Museum of Natural History in January, bringing a carload of fossil dinosaur bones, chiefly from the Belly River Cretaceous formation of Alberta. The collection comprises two complete skeletons; one of the horned dinosaur *Ceratops,* of which the museum previously possessed only skulls; the other of the helmeted dinosaur *Stephanosaurus,* not before represented in the museum's collection. Other notable specimens are a complete skull and jaws of the horned dinosaur *Monoclonius;* a skull and part of the skeleton of an armored dinosaur; and the largest skull yet discovered (five feet in length) of the duck-billed dinosaur, *Trachodon.* Another very rare specimen is a complete lower jaw of a cretaceous marsupial mammal. In addition to the vertebrate remains, two large silicified tree trunks were secured, over forty feet in length. When these are sectioned it will be possible to determine the genus to which they belong. They are of especial interest because the center of the tree is silicified, while surrounding it the outer portion had carbonized, forming lignite. Several large slabs were also obtained on which impressions of many species of leaves are beautifully preserved. This material will be displayed to show the type of foliage contemporaneous with the dinosaur life of Alberta. After bringing to completion the museum's work on the Red Deer River, which has extended over a period of six years and been productive of four and a half carloads of valuable fossils, Mr. Brown went to Northern Montana. Here he secured a large collection from the Upper Cretaceous beds on Milk River. Work was continued in this field until zero weather compelled cessation of operations.

THE Philadelphia Academy of Surgery announces that essays for the Samuel D. Gross prize of fifteen hundred dollars will be received until January 1, 1920. The conditions are that the prize "shall be awarded every five years to the writer of the best original essay, not exceeding one hundred and fifty printed pages, octavo, in length, illustrative of some subject in surgical pathology or surgical practise, founded upon original investigations, the candidates for the prize to be American citizens."

UNIVERSITY AND EDUCATIONAL NEWS

DR. JOHN C. DUNCAN has been appointed professor of astronomy and director of Whitin Observatory of Wellesley College. Professor Sarah F. Whiting retires at the close of the present academic year as does also Professor Ellen Hayes. Professor Whiting, a pupil of Professor E. C. Pickering at the Massachusetts Institute of Technology before he became director of Harvard Observatory, gave the first lectures in astronomy at Wellesley College in

1879, as a course in applied physics. A portable four and a half inch telescope was the only available instrument until 1900, when the beautiful Whitin Observatory equipped with twelve-inch telescope, three-inch transit, all necessary apparatus, and an adequate library in astronomy was opened, through the generosity of Mrs. John C. Whitin, a trustee of the college. In 1906 the observatory was doubled to make room for the teaching of astronomy as other sciences are taught by the laboratory method, and a residence for the astronomers was added. Professor Hayes, head of the department of applied mathematics, a pupil of Ormund Stone, meantime conducted work in mathematical astronomy. In 1901 the department of astronomy was created, including both the astrophysical and the mathematical sides of the subject. Dr. Duncan has worked at Lick, Lowell and Yerkes observatories, and has taught at Harvard and Radcliffe Colleges.

Frank H. Probert, a graduate of the Royal School of Mines in London, and for the past twenty years engaged in consulting mining engineering practise, has been appointed professor of mining in the University of California, as successor to the late Professor Samuel Benedict Christy.

Dr. Jesse F. Williams, assistant professor of hygiene and physical education at Columbia University, has been appointed professor of hygiene and physical education in the University of Cincinnati.

Dr. Henry W. Wandless has been appointed clinical professor of ophthalmology at New York University and Bellevue Hospital Medical College.

Dr. Edward H. Horton, director of the bacteriologic department of the Tri-Cities Hygienic Institute, LaSalle, has resigned to become bacteriologist in the Northwestern University Dental College, Chicago.

Dr. Sterling Temple, instructor in chemistry in the University of Minnesota, has accepted a position as professor of chemistry at Hamline University, and will take up his work there in the autumn.

At Ohio Northern University, Joseph Hamilton Hill has become professor of mathematics.

Sir R. Havelock Charles, president of the medical board of the India Office, has been appointed dean of the London School of Tropical Medicine in succession to the late Sir Francis Lovell.

DISCUSSION AND CORRESPONDENCE

A NEW FORM OF PLANT DRIER

A number of notices have been published[1] regarding the use of single or double-faced corrugated straw board as a means of rapid drying of plants for herbaria. Some have omitted the use of the customary driers with the corrugated boards, a procedure which has a tendency to cause the plants to be somewhat wrinkled. It has also been recommended that the boards be cut so that the corrugations run crosswise of the board. The pressure of the straps around the press, however, has a greater tendency to close up the ends of the corrugations when they run crosswise than when they run lengthwise. To avoid handling two driers and a corrugated board for every plant placed in press the writer adopted the plan several years ago of fastening at the corners with a wire stapling machine two driers with a corrugated board between. This procedure saves two thirds of ones' time in handling the corrugated boards and two driers in the old way. While this form of drier worked very satisfactorily when hot sunshine or artificial heat was available for drying it made the drying material much thicker than necessary. An order was consequently given to a local firm for a special drier consisting of two pieces of ordinary felt drying paper with a corrugated filler such as is used in the single and double-faced corrugated straw board. This material has given entire satisfaction and can be obtained in large quantities at a cost of about $16.56 per 1,000 as compared with

[1] Kellerman, W. A., Science, N. S., 27: 67–70, 1908; Collins, J. F., *Rhodora*, 12: 221–224, 1910; Conrad, H. S., *Plant World*, 15: 135–139, 1912; Ricker, P. L., Bureau of Plant Industry Circ., 126: 27–35, 1913.

$10 per 1,000 quoted by one firm for medium weight and $14 per 1,000 for heavy weight driers. When it is considered that a large part of the material pressed under the old system, using blotters alone, required the use of two blotters between each specimen, it will be seen that a considerable saving is effected in the cost of the drying material as well as in the time required to handle and completely dry the material.

P. L. RICKER
BUREAU OF PLANT INDUSTRY

A NEW COLOR VARIETY OF THE NORWAY RAT

NORWAY rats with dilute coat color have recently been taken in the vicinity of the University of Pennsylvania. If we may judge from the fact that the nine individuals thus far found are all approximately alike and are distinctly different from the normal type, they probably represent a new Mendelian variety.

The coat is intermediate in color between that of the ordinary dark form and the albino and resembles that of the red-eyed guinea pig. In the guinea pig this color has been shown by Wright to be allelomorphic with albinism and with dilute. As in the guinea pig, the hair of the new rat seems to be without yellow pigment and is dilute black or brown ticked with white.

The eyes look black unless the light is very bright. When the light shines directly into them they appear pink. They are distinctly lighter than the eyes of Castle's red-eyed yellow rats, but darker than those of his pink-eyed yellows.

The new rats are now in the care of the Wistar Institute, where the endeavor is being made to increase the stock and to cross with the color varieties already known.

Data in regard to the distribution of the new form is being collected and will later be published.

The previously known Mendelian varieties in the rat are five: black, hooded, albino and Castle's two yellow varieties, red-eye and pink-eye. This new variety is a non-yellow dilute and may be called ruby-eye.

PHINEAS W. WHITING
UNIVERSITY OF PENNSYLVANIA

SYLVESTER AND CAYLEY

UNDER the portrait with which the editor has adorned my article "Sylvester at Hopkins," in *The Johns Hopkins Alumni Magazine* of March, 1916, the designation is simply "James Sylvester."

This omits his real name, his family name, the name to which he was born; for his father was Mr. Abraham Joseph, his two sisters were the Misses Joseph. The name by which we know him he chose for himself, following the example of his eldest brother, who early in life established himself in America and assumed the name of Sylvester.

My laborious and critical friend, Professor G. A. Miller, of the University of Illinois, in his recent book "An Introduction to Mathematical Literature," commits the colossal error of representing Sylvester and Cayley as friends together at college, Cambridge chums, whereas Sylvester entered Cambridge in 1831 and Cayley was senior wrangler at Cambridge in 1842, more than a decade later. Sylvester had already in the session 1837–38 been appointed professor in London University College, and it was in London, but only after the lapse of nearly another decade, in fact in 1846, that Cayley met Sylvester.

GEORGE BRUCE HALSTED
GREELEY, COLO.

SCIENTIFIC BOOKS

Indian Mathematics. By G. R. KAYE. Calcutta & Simla, Thacker Spink & Co., 1915. Pp. 73.

Of all the British writers on the history of Indian mathematics at the present time, none is better known or more serious in his purpose than Mr. Kaye. A scholar by nature and, through his connection with the Indian service, placed in an environment which is conducive to the study of the original sources, few men have the opportunities which are his for bringing the mathematical learning of the East to the knowledge of the West.

This being the case, the reader might naturally expect to find in a publication with such a title as this an exhaustive and well-

balanced treatment of the general field of native Hindu mathematics. In this anticipation he will, however, be disappointed. Mr. Kaye's mind runs rather to monographs than to treatises, and these monographs are generally of real value to those who are less fortunately situated with respect to the sources of information. But in the present instance he has given us a monograph with a rather pretentious title which does not seem quite worthy of his undoubted powers. It is, of course, characterized by Mr. Kaye's prejudice against any claims of originality on the part of the Hindu scholars, but this feature is rather less obtrusive than in his other monographs, and in any case a reader can overlook a bias of this kind if he is presented with the evidence in such a fashion as to allow of its being weighed by himself. But the work is by no means an exhaustive presentation of Indian mathematics and it contains but little that is not already familiar to the students of history.

Mr. Kaye divides the subject into three historic periods: (1) the S'ulvasūtra period, extending to about A.D. 200; (2) the astronomical period, extending from about A.D. 400 to 600; (3) the Hindu mathematical period proper, extending from A.D. 600 to 1200, after which there was no native mathematics worth mentioning.

The word S'ulvasūtra means "the rules of the cord," and applies to certain verses treating of the construction of altars. The connection with the Egyptian "rope-stretchers" (harpedonaptæ) will occur to every one who has considered the history of ancient geometry, and, like so many parallels of this kind, is suggestive of the early intercourse between the East and the West. The dates of the S'ulvasūtras are uncertain, and the manuscripts show many variations due to different scribes, but we know to a certainty enough about them to render their study of interest in the history of mathematics. The Pythagorean theorem is stated with some generality, although there is nothing to show whether it was an independent product of India, or came from China, where it seems to have been already known, or worked its way eastward from the Mediterranean civilization, perhaps at the time of the visit of the forces of Alexander. The unit fraction is in evidence, as it was in Egypt and Babylon two thousand years earlier. The mensuration of the circle is also a feature of the S'ulvasūtras. The most interesting suggestion made by Mr. Kaye in this connection relates to a circle of diameter d and area a^2, namely, that the relation

$$d = a + \tfrac{1}{3}(a\sqrt{2} - a),$$

which is given in the editions of Āpastamba and Baudhāyana, led to the relation

$$a = d\left(1 - \frac{1}{8} + \frac{1}{8.29} - \frac{1}{8.29.6} + \frac{1}{8.29.6.8}\right)$$

through the substitution for $\sqrt{2}$ of

$$1 + \frac{1}{3} + \frac{1}{3.4} - \frac{1}{3.4.34},$$

which value is given earlier in the S'ulvasūtras. Mr. Kaye asserts, however, that this substitution was beyond the powers of the Hindu mathematicians of that period, and it is a fact that we have no other evidence of any ability to make such a substitution.

As far as our present knowledge goes, there is a gap between the S'ulvasūtra mathematics and the first distinct treatises on the subject, such as the Sūrya Siddhānta, the anonymous astronomical classic of about A.D. 400. This work was included in the great collection made by Varāha Mihira in the sixth century, and the evidence seems to show that, by this time, more or less of Greek mathematics was known in India. Ptolemy's influence seems to be evident in the table of chords given by Varāha Mihira, but the earliest known use of the sine occurs in the Hindu works of this period.

Mr. Kaye summarizes the work of Āryabhaṭa in a satisfactory manner, making no mention of the younger mathematician of the same name to whom he devoted some attention a few years ago. Indeed, his statement that "the Indian works record distinct advances on what is left of the Greek analysis" is perhaps the most outspoken statement in favor of the Hindu algebraists to be found in any of his writings.

Noteworthy among the special topics studied by Mr. Kaye are the Hindu methods of solving the equation $Du^2+1=t^2$, beginning with Brahmagupta in the seventh century, together with a conspectus of the indeterminate problems dealt with in India. The problems of the rational right triangle and the value of π, attractive ones to the Hindu writers from Brahmagupta on, are also studied by Mr. Kaye and two helpful synopses are given. A brief study of the connection between Chinese and Hindu mathematics is also given, and the proof which is adduced seems to be valid that Mahavir, in the ninth century, was acquainted with certain Chinese works. This acquaintance appears, for example, in the treatment of the area of a segment of a circle and in two or three applied problems. It is doubtful, however, if this relationship and others like it are sufficient ground for the sweeping assertions contained in the following statements:

> That the most important parts of the works of the Indian mathematicians from Aryabhaṭa to Bhāskara are essentially based upon western knowledge is now established. A somewhat intimate connection between early Chinese and Indian mathematics is also established. That the Arabic development of mathematics was practically independent of Indian influence is also proved.

It would be safer to say that the solution of the problem of the relationship between the scholarship of the East and that of the West has hardly yet been begun.

Two helpful features of the work are the large number of extracts from the original treatises, and a fair bibliography. Mention should also be made of two interesting photographic reproductions, one of two pages of Śrīdhara's *Triśátikā* and the other of three pages of the Bakhshālī manuscript. There is also a helpful index to the work.

The book, small though it is, should be on the shelves of all who are interested in Oriental mathematics. It is to be hoped that Mr. Kaye will some time prepare a more exhaustive work upon the subject.

DAVID EUGENE SMITH

Assaying in Theory and Practise. By E. A. WRAIGHT, of Royal School of Mines, London. Longmans, Green and Co. Pp. 316. 86 figures in text. $3.00.

The text of the book is divided into four parts. *First:* Numerical Data, Laboratory Plans, Lists of Apparatus, Minerals and Their Characteristics. *Second* Part: Dry Assaying; contains chapters on tests for recognition of various metals, sampling, general assay problems and methods of assay for tin, gold, silver, lead, mercury, fuels and refractory materials. *Third* Part: Wet methods for iron, copper, zinc, aluminum, lead, bismuth, tin, tungsten, arsenic, antimony, manganese, chromium, sulphur, vanadium, cobalt, nickel, uranium and molybdenum. *Fourth* Part: Control tests for cyaniding solutions and cyaniding methods.

It is rather doubtful whether any one, who was not fairly well grounded in chemistry and chemical manipulation, could make much progress in assaying by the use of the book alone. The methods given leave much to the mind of the reader. In the tests for recognition, a wet and a dry test are given for each element. No mention is made of the influence of other elements which may hide the test entirely. In the description of grinding no mention of the mechanical grinders is made. The iron mortar and the backing board are recommended, notwithstanding the fact that some form of mechanical grinder is found in almost every assay laboratory.

Gas furnaces and oil furnaces are also omitted from the description. These furnaces may not be in common use in England, but they are found everywhere in this country.

The reviewer does not agree with some of the methods recommended, but that is perhaps only a difference of opinion.

But one form of calorimeter is described, but the principles of calorimetry are well described.

The book furnishes much in a suggestive way and may be taken as a good outline for a course in assaying, but the course would have to be supervised by a competent instructor.

OWEN L. SHINN

MOSQUITOES AND MAN

A UNIQUE deduction, and one likely to be of great value to sanitarians has been reached as one of the results of the work done in the Canal Zone by Major P. M. Ashburn, Medical Corps, U. S. Army. As general inspector, health department, Canal Zone, Major Ashburn became intimately acquainted with the breeding conditions there, and one result of his observation may be summed up in his statement "*the malarial mosquito follows man.*" This means also that their breeding places are normally within convenient reach of human habitation and becomes a very effective as well as an entirely new viewpoint of already recognized conditions, and a viewpoint it would be wise to keep in mind wherever health, efficiency and mosquito control are to be considered.

Major Ashburn in referring to the well-proven flight of anophelines of "more than a mile from their place of breeding" draws attention to the facts[1] that there is at this particular location "a large area where the conditions for breeding are unusually favorable . . . an enormous amount of breeding . . . lack of abundant human blood for food in the neighborhood of the breeding place, *the presence of abundance of food* (a town) at a distance of a mile," and goes on to say "were there another town within two hundred yards or a quarter or half of a mile, the chances are that the town a mile away would scarcely notice any change in the number of mosquitoes." "In fact such has been the experience at several places on the Isthmus," and, referring to another location adds: "The conditions favored a big flight, but a human barrier in the neighborhood served to check it and make the increase of mosquitoes merely a local one."

In another paper[2] Major Ashburn speaks of the conditions in the Canal Zone where places that had been "great hot beds of malaria, and great breeding places for *Anopheles albimanus,* now, since their depopulation, have very few or no *Anopheles*" mentioning the water works at Miraflores, Cocoli, Ancon Village as examples and refers to a few instances where *Anopheles* which "were supposed to have come from considerable distances, the situations were found controllable by intensive effort expended close at hand," while the hydraulic fills at several places which gave rise to much increased breeding did not give rise to flights of great length, because "there was food nearer at hand."

Naturally the interposition of "an animal barrier between extensive *Anopheles* breeding places and human habitation" was considered, but this was found to have already been proven of small or no value.

Major Ashburn then evolved an hypothesis including "(*A*) *Parasitism,* (*B*) *Long Flights,* (*C*) *Anopheles breeding far from man not malarial carriers.*" It is with the last point we are most concerned, although, of course, the three parts are really interdependent.

Major Ashburn calls attention to the fact that *Anopheles apicimaculatus,* not a malaria carrier, was often found breeding 800 yards from human habitation, and that even a temporary construction camp of a large gang of negroes was enough to bring malaria carriers to a given place, and the removal of the laborers was followed by a discontinuance of the breeding of malaria carriers at that place.

Finally, at a contractor's camp, established November 26, 1913, at Caño Saddle, in a previously uninhabited location, hand catching of mosquitoes showed an increase in the weekly takings of malaria carriers as indicated in the following partial table:

Week Ending	Malaria Carriers
December 6, 1913	6
December 13, 1913	34
December 20, 1913	165
December 27, 1913	115
January 31, 1914	1,211
March 7, 1914	3,277
May 9, 1914	87

[1] Ashburn, P. M., Major, Medical Corps, U. S. A., "Elements of Military Hygiene," 2d ed. (1915), pp. 285.

[2] Ashburn, P. M., Major, Medical Corps, U. S. A., general inspector, health department, Panama Canal, "Some Observations Bearing on the Control of Malaria." Read before the Canal Zone Medical Association, late in 1914.

After which, at the approach of the dry season, and the discontinuance of the camp early in May the numbers gradually lessened.

So far as the incidental appearance of malaria is concerned, while Major Ashburn says the reports are perhaps unduly favorable, the first case was sent into hospital February 7. In December, shortly after the opening of the camp it was inspected and malaria was predicted, but was not then present; in February two cases were reported, by the last of March the percentage on blood examination had risen to 20 per cent., and in April to 100 per cent.

It is to be noted that these *Anophelines* "did not greatly abound until after the laborers had been at this location for three weeks or more, and malaria made no headway until after two months."

From these observations Major Ashburn concludes, although for very different reasons than the usual ones of ability in length of flight, that "in ordinary sanitary practise, and not considering such exceptionally large and favorable breeding places, the control of all breeding within four hundred yards of towns, posts and houses serves to make them fairly comfortable and safe residences."[3]

It is however the difference in reasons that makes Major Ashburn's conclusions of especial value, and the whole of Major Ashburn's paper is well worth study. It throws an absolutely new light on the subject, gives a valid reason for the acknowledged limit of four hundred yards as the usual flight of *Anopheles,* and clears up some points in mosquito control that have hitherto been obscure and bewildering.

C. S. LUDLOW

ARMY MEDICAL MUSEUM,
WASHINGTON, D. C.,
May 4, 1916

[3] Ashburn, P. M., "Elements of Military Hygiene," 2d ed. (1915).

SPECIAL ARTICLES

THE ORIGIN BY MUTATION OF THE ENDEMIC PLANTS OF CEYLON

IN a recent paper Dr. J. C. Willis has made a statistical study of the flora of Ceylon in order to show that the indigenous species of this island must have been developed by mutation and without any kind of advantageous response to local conditions.[1]

It is obvious that the mutation theory wants in the first place a study of those facts which may throw a direct light on the evolution of wild species and that only relatively young forms have a sufficient chance of still living under the same or almost the same conditions, under which they originated. The material, afforded by the flora of Ceylon, is exceptionally rich in this respect and thoroughly well prepared by numerous investigators and especially in the great "Flora of Ceylon" by Trimen and Hooker.

Ceylon is a comparatively small island (25,000 sq. miles) and has a flora of 2,809 species of Angiosperms, of which 809 are endemic to the island.

Moreover of the 1,027 genera to which those species belong, 23 are confined to Ceylon, and among the 149 families, this is the case with six. Among the endemic genera 17 are represented by one species only, four by 2–3 and only two by a large number. These latter are *Doona* with 11 and *Stemonoporus* with 15 species, almost all of which are very rare forms, but distinguished from one another by characters of full specific rank. They give the impression that they may have been formed by what *Standfuss* has called explosive methods, a number of new species being produced almost at the same time.

As a rule, the endemic species are rare or very rare. More than a hundred of them are confined to one mountain top or to some very small area in the mountains.

Many of these occur as a very few individuals, say a dozen or little more, and the places where they can thrive are so small that it is obvious that they can never have been much more numerous. They must have evolved on the spot where they are found. Notwithstanding this, they are well-marked Linnean species and accepted as such by Trimen and Hooker. Not rarely their distinguishing characters are relatively large.

[1] J. C. Willis, "The Endemic Flora of Ceylon, with Reference to Geographical Distribution and Evolution in General," *Phil. Trans. Roy. Soc. London,* Series *B,* Vol. 206, pp. 307–342.

In drawing such conclusions, however, even from a thorough knowledge of a flora, one is often exposed to lay too much stress on striking but exceptional instances, whereas it is only averages which may really be relied upon. For this reason Willis has worked out a method, which gives a large degree of accuracy and thereby affords a firm and unattackable basis for his deductions. Trimen divides all species into six classes: Very Common, Common, Rather Common, Rather Rare, Rare and Very Rare, and his estimates are thoroughly reliable, as is shown by the clearness and regularity of the results derived from them.

In order to compare two or more groups of species Willis multiplies the number of species in them, belonging to each of these classes by a factor indicating the degree of rarity according to the estimates of Trimen. These factors are 1 for very common, 2 for common and so on, up to 6 for very rare. In this way averages may be calculated, which give the relative degree of rarity for any group under consideration.

Next, the plants of Ceylon are divided into three main groups, one containing the endemic species, the second those confined to Ceylon and Peninsular India, and the third the forms of wider (although often not very much wider) distribution. In this way Willis finds:

	No. of Species	Rarity
Mean rarity of all species ..	2,809	3,5
Species of wide distribution.	1,508	3,0
Of Ceylon and Peninsular India	492	3,5
Species endemic to Ceylon...	809	4,3
Species of all 23 endemic genera	52	4,5
Species of *Doona* (endemic)..	11	4,6
Species of *Stemonoporus* (endemic)	15	5,4

Thus the species of wide distribution are the commonest, those of Ceylon and India have just the mean degree of rarity, but the endemics are relatively rare, the rarest of all being the species of the endemic genera and especially those of the only two genera which are rich in endemics. Results of the same kind, obtained by applying this method to different manners of bringing the species of this island into groups, are given in numerous tables, the study of which will be of great importance to all scientists interested in the subject.

One of the main results is that the variation in rarity between the different families or groups of families of Ceylon-endemics is small, and goes to show that no one family has any particular advantage over another. In comparing the genera with one another the same rule prevails, independent of the question which genera are chosen and from which point of view the comparison is made.

The order of rarity: Ceylon, Ceylon and Peninsular India, Wider Dispersal, holds throughout all comparisons with extraordinary regularity. It is obvious that some general law must be underlying these phenomena.

If the endemic species had originated by natural selection of infinitesimal steps and in response to the local conditions, which are obviously the only conditions that matter when the species first appears, they must have been, from this very origin, better adapted to these conditions than their parent species. According to the theory of natural selection it would follow that they must surpass their forerunners in the struggle for life and soon spread to a higher degree of commonness. But as the table shows, the reverse is true. Yet they have had ample time even for gaining a comparatively wide dispersal. Several recently introduced species have spread to the stage of very common, often in a few years. *Tithonia diversifolia,* one of the Compositæ, began to spread about 1866 and in 1900 was all over the island in damp enough spots. *Mikania scandens* began to spread ten years ago and is already common all around Peradeniya. Many other instances could be given, since about 60 introduced species have become more or less common in the island.

Of the 809 endemics of Ceylon only 90 are now common and only 19 very common in the island, the remainder are mostly rare or very rare. If they did not conquer their parents and spread into larger areas, it is obvious that they were not especially adapted to the condi-

tions prevailing in the island, and at least not better adapted than the species from which they sprung. Or, in other words, that they did not originate in advantageous response to those local conditions. A large amount of facts and considerations has been brought forward by the author in order to justify this conclusion.

These conclusions provide us with a strong argument against the hypothesis of a slow and gradual evolution by small and almost invisible steps, and for the theory of their production by mutations. In the rare cases of rapid dispersal of new species a better adaptation may of course be assumed as one of the chief factors, but on the average the dispersal is very slow in the beginning, giving no argument in favor of this view.

Furthermore these considerations lead to the view that wide distribution and commonness are chiefly dependent on age, and only rarely on adaptation. In every family the genera with the widest distribution may be considered as the oldest, those with a smaller domain as younger, and the local endemics as the youngest of all. These principles will be used in subsequent studies to draw pedigrees of families. But the studies made by the author up to this time go to show that nearly all families have the same general type of distribution, that evolution of forms is on the average indifferent, and that most of the so-called adaptations are of no special advantage to their possessors.

Another argument relates to the possible size of mutations. It is often assumed that mutations must of necessity be small, considering that it seems probable that only one unit-factor will be changed at a time. This conception seems to the author to be an unnecessary handicap to the theory of mutation and he proposes that it should be replaced by the hypothesis that no specific change is too great to appear in one mutation. The difference between endemic species of Ceylon and their nearest allies is often very large, as may be deduced from the fact that they are accepted as well-marked Linnean species by such authorities as Trimen and Hooker. But in many cases they are even larger. For instance, *Coleus elongatus,* which occurs only on the top of Ritigala and here only in about a dozen of individuals, differs so much from all other *Colei,* that it may well be regarded as subgenerically distinct. And for the 17 endemic genera, which have only one species each, it seems at least very probable that the whole genus has arisen at a single step.

In concluding I might state that my own studies on the production of new forms among the Œnotheras have of late led me to the conclusion that mutations are in many cases of a far more complicated nature than has been assumed until now. Many of them, as for instance the production of *O. rubrinervis, O. nanella* and *O. gigas,* involve the simultaneous change of two or more characters, in some cases of quite a large number of unit-factors. Why these changes should so regularly go together, we do not, as yet, know, but the fact goes to increase the analogy between the experimental mutations of these plants and the mutations in the wild condition of the Ceylon endemics.

From the facts adduced by Willis, and reviewed in this article, it seems obvious that the parallelism of natural and experimental mutations is a very close one.

HUGO DE VRIES

ELECTRICAL DISCHARGE BETWEEN CONCENTRIC CYLINDRICAL ELECTRODES

IN operating vacuum tubes we invariably use an induction coil or an electrostatic machine. The discharge in either case is never quite steady and hence these methods of operation do not lend themselves well to a critical study of the growth of the cathode dark spaces. A steady, and of course continuous, discharge may be had if the current is drawn from a high potential storage battery. Ordinarily it takes more cells than are available; however, by a right choice of conditions a rather extended study may be made with direct current potentials of less than 1,000 volts. The following experiments with concentric cylindrical electrodes were performed recently by the writer in class demonstration.

The discharge vessel consists of an ordinary

three-quart battery jar. A hole bored through the bottom receives the evacuating tube, the junction being made airtight with ordinary sealing wax. The lip of the jar is ground flat to receive the plate glass lid. The junction here is made by means of the frequently used half-and-half wax, beeswax and resin. This wax because of its low melting point admits of easy removal of the glass plate. The electrodes are concentric cylinders and may well be made of sheet aluminum—one electrode to fit snugly the inner wall of the jar, and the other mounted on a cylinder of glass tubing about 1½ inches in diameter, which in turn is supported accurately concentric by sealing wax from the bottom of the jar. Outside connections to the electrodes are made by fine bare copper wire run out through the waxed joints. The assembled discharge vessel is shown at *a* in Fig. 1.

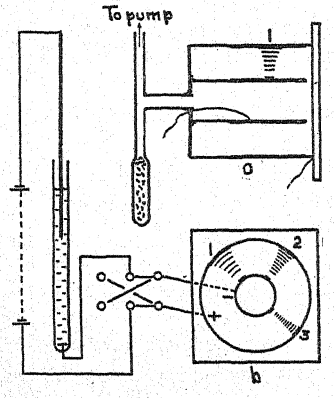


Fig. 1.

The vessel may be exhausted by a Gaede mercury or a Gaede piston pump and, if desired, the vacuum carried farther by the use of charcoal and liquid air, though the latter is not necessary. The potential employed by the writer to produce the discharge was furnished by a cabinet of high potential storage cells of 1,000 volts.

Two methods of operating were employed. In the first an adjustable water resistance is connected in series with the cells and discharge vessel as shown at *b* in Fig. 1. When the vacuum is right a beautiful discharge will make its appearance as patches of light on the electrodes. These patches of light, when there is considerable resistance in the circuit and the vacuum is not very high, will be opposite each other and the discharge, as a whole, will wander about, sometimes swinging entirely around, or at times travelling to the edges of the electrodes, only to break away and move to some other point. The movement of the cathode glow (which is the smaller and hence the brighter) is similar to that of the cathode star over the surface of mercury in a mercury vapor lamp. These areas grow as the vacuum improves when ultimately the entire surface of each electrode is covered. Or, with the vacuum kept constant, the areas may be made to increase in size by cutting out resistance. Hence by improving the vacuum and at the same time cutting out resistance the discharge, if the inner cylinder is made cathode, grows rapidly into a brilliant bull's-eye. The appearance is very realistic, for if now resistance is cut in, the dark space around the cathode (as is evident after a moment's reflection) grows smaller, and *vice versa*. Its

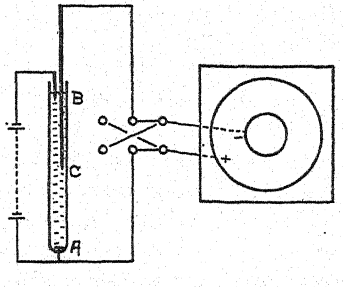


Fig. 2.

outline is exceedingly sharp and perfectly steady, and yet, though the discharge appears very brilliant, the current required may not exceed 20 milliamperes.

This form of discharge vessel offers an interesting method for the study of the striations and their relative spacing with reference to the impressed discharge potentials. These effects are best shown when the vacuum is not too high and the discharge potential is adjusted to give a patch on the cathode, which

we will take as the inner cylinder, of about one square centimeter in area. Under these conditions the Faraday dark space should be about 8 mm. in length, and the Crookes dark space should be just visible between the velvety cathode glow and the cathode electrode. Another prerequisite is that the discharge must not cling to the edge of the aluminum electrodes, but should occupy some intermediate position as shown at 1 in *a*, Fig. 1. In this position the characteristics of the discharge are shown with exceeding clearness. If now some additional resistance is cut in, the area of the discharge will become less, the Faraday dark space will shorten, the positive column will move towards the cathode, and the number of striæ in it will increase, the extra striæ being, as it were, drawn out of the anode. The configuration is perfectly steady except that the discharge, as a whole, is liable to wander. This transition may be continued by a still further increase of the resistance in the circuit, the dark space becoming ever shorter, the positive column lengthening and at the same time shrinking in area and the striæ increasing in number, all without loss of outline or brightness. Finally, the discharge will cease. The various stages are suggested at 1, 2, 3 in *b*, Fig. 1.

In the second method the discharge vessel with its commutator is placed in a derived circuit (Fig. 2). This arrangement enables the discharge potential to be continuously varied over a wide range, and hence for a given vacuum the relation between the length of the dark space and the impressed voltage may be exhibited. Again this arrangement enables the minimum potential to be readily determined that will maintain a discharge. As an example, for a given vacuum with the resistance AC equal to 1/3 that of AB the discharge was observed to just pass, indicating that the potential necessary was 330 volts.

Additional phases of the experiment will suggest themselves to the operator.

CHAS. T. KNIPP

LABORATORY OF PHYSICS,
UNIVERSITY OF ILLINOIS,
March 4, 1916

UTAH ACADEMY OF SCIENCES

THE ninth annual convention of the Utah Academy of Sciences was held in the chemistry lecture room of the University of Utah. Three sessions were held: one at eight P.M., Friday, April 7, one at ten A.M., Saturday, April 8, and the closing session at two P.M. of the same day. Dr. Harvey Fletcher presided at all of the sessions.

Dr. E. G. Peterson, U. A. C., and Professor Carl F. Eyring, B. Y. U., were elected to fellowships in the academy. The following were elected members: Professor George B. Caine, U. A. C., Dean Milton Bennion, U. U., Professor Newton Miller, U. U., Professor A. L. Matthews, U. U., Dr. George S. Snoddy, U. U., Miss Hazel L. Morse, East High School, Salt Lake City, C. Arthur Smith, East High School, Salt Lake City, C. Oren Wilson, East High School, Salt Lake City, Professor Estes P. Taylor, U. A. C., Dr. A. P. Henderson, B. Y. U., and Edgar M. Ledyard, Salt Lake City.

Captain Francis Marion Bishop, a companion of Major Powell in his famous explorations of the Uinta Mountains, was elected to honorary life membership.

The following officers were elected for the ensuing year:

President—Dr. Frank Harris, U. A. C., Logan.

First Vice-president—Dr. L. L. Daines, U. U., Salt Lake City.

Second Vice-president—Professor Carl F. Eyring, B. Y. U., Provo.

Councillors—Dean J. L. Gibson, U. U., Dr. W. E. Carroll, U. A. C., W. D. Neal, Salt Lake City.

The following lectures and papers were presented:

"Industrial Research in U. S. A.," by Dr. Harvey Fletcher, B. Y. U.

"The Alkali Content of Certain Utah Soils," by Dr. Frank S. Harris, U. A. C.

"The Agricultural College and Scientific Research," by Dr. E. G. Peterson, U. A. C.

"Selecting Holstein-Friesian Bulls by Performance," by Dr. W. E. Carroll, U. A. C.

"Peyote, an Indian Narcotic," by A. O. Garrett, East High School, Salt Lake City.

"An Epidemic of Colds with *Micrococcus catarrhalis* as Causative Agents," by Dr. L. L. Daines, U. U.

"The First Recorded Case of Rabies in Utah," by Dr. L. L. Daines, U. U.

"Botulinus Poisoning from a Vegetable Source," by Dr. L. L. Daines, U. U.

"Comparison of Methods of Treatment for

Grain Smuts,'' by M. Rich Porter, Salt Lake City.

''The Value of Gaseous Ionization in Hydrogen,'' by Professor Carl F. Eyring, B. Y. U.

''A New Count Method of Measuring the Elementary Electric Charge,'' by Dr. Harvey Fletcher, B. Y. U.

''Our National Awakening to the Importance of Science,'' by Dr. W. C. Ebaugh, Salt Lake City.

A. O. Garrett,
Permanent Secretary

ANTHROPOLOGY AT THE WASHINGTON MEETING[1]

The annual meeting of the American Anthropological Association was held December 27–31, 1915, at the United States National Museum, Washington, D. C., its scientific sessions being in affiliation with Section I of the Second Pan-American Scientific Congress, the Nineteenth International Congress of Americanists, the American Folk-Lore Society, the American Historical Association, and the Archeological Institute of America. By virtue of this affiliation the attendance was large and the list of papers presented bearing on anthropology was unusually long.

In honor of the occasion, the United States National Museum made provision for special exhibits. These included: (1) Physical Anthropology, by Dr. A. Hrdlicka; (2) Indian Treaties of Historical Importance; (3) Economic Plants and Plant Products, by W. E. Safford; (4) Archeological Exhibits, by W. K. Moorehead, A. V. Kidder, and Julio Tello, and (5) Photographs, by Frederick Monsen and the Rodman Wanamaker Expedition.

Interwoven with the scientific sessions there was an elaborate social program, comprising a reception by the Secretary of State and the United States delegation, and one by the governing board of the Pan-American Union, both held in the Pan-American building; a reception by the regents and secretary of the Smithsonian Institution; a luncheon by the National Geographic Society; a reception by the trustees of the Carnegie Institution of Washington; a dinner and reception by the Cosmos Club; and finally after the close of the meetings, the reception at the White House by the President and Mrs. Woodrow Wilson.

A number of important resolutions were adopted; some of these were in the nature of joint resolutions, others concerned only the American Anthropological Association, as will be seen from the contexts:

[1] Report prepared by George Grant MacCurdy at the request of the General Secretary, A. Hrdlicka.

RESOLUTION RELATING TO THE DESIRABILITY OF UNIFORM LAWS CONCERNING ARCHEOLOGICAL EXPLORATION

Section I

Whereas, many parts of the American continent are rich in archeological remains, such as ruins, monuments and burial sites, containing many examples of industry and art of the aborigines.

And whereas, scientific explorations of these remains with the study of resulting finds are objects of utmost importance, for on their basis only will it be once possible to reconstruct the lost history of the American race.

And whereas, in order that such remains may be saved to science and not be wantonly exploited or destroyed before they could be studied, it is essential that proper laws and regulations be adopted by the various countries where such remains exist, the object of such laws and regulations being to hinder or prevent as far as possible the digging or other destruction of such remains by unqualified persons; to prevent trade in pottery and other articles recovered from the ruins and graves, and at the same time not only to enable properly qualified scientific men both indigenous and of other countries to undertake and carry on scientific explorations and collections.

And whereas, the majority of the American republics have now some laws relating to antiquities, although these laws are unlike in the different countries and in some instances are such that they have resulted more in restraining than in advancing properly qualified research.

Therefore it is hereby Resolved by the Second Pan-American Congress, that it is highly desirable that the various American republics arrange by the appointment of suitable delegates, possibly from among their official representatives at Washington, for joint action on this important subject, with the view of formulating generally acceptable and substantially uniform laws relating to the conservation, exploration and study of archeological remains in their several jurisdictions; laws which on one side will effectively safeguard these remains from wanton destruction or exploitation, and on the other will aid and stimulate properly organized and accredited research in these directions.

RESOLUTION RELATING TO THE ADVANCE OF ANTHROPOLOGICAL RESEARCH IN THE VARIOUS AMERICAN REPUBLICS

Whereas, in various parts of the American continent there are remnants of the aboriginal popu-

lation, a study of which is of great importance to science.

AND WHEREAS, many of these remnants are very imperfectly known and are rapidly disappearing.

AND WHEREAS, properly made and preserved collections, ethnological and physical, are among the most precious scientific and educational assets of a nation.

Therefore be it Resolved by the Second Pan-American Congress, that delegates to the congress be urged to use every opportunity to impress upon their respective governments, institutions and people the importance of promoting research in this field, of organizing surveys for the study of the primitive tribes, and of building up national and local museums for the preservation of the data and materials collected.

The two foregoing resolutions were passed not only by the American Anthropological Association, but also by the International Congress of Americanists, the latter providing for an intermediary local bureau in Washington consisting of W. H. Holmes, F. W. Hodge and A. Hrdlicka.

RESOLUTION ON THE DEATH OF PROFESSOR FREDERIC WARD PUTNAM

(Prepared by Alfred M. Tozzer and Marshall H. Saville.)

WHEREAS, by the death of Professor Frederic Ward Putnam, the American Anthropological Association has lost one of its most eminent founders, one of its most eminent supporters, and one of its most lovable characters;

Be it Resolved, that the Association here express the sense of this great loss to American anthropology, a loss that is felt not only by the many pupils of Professor Putnam in the several institutions throughout the country, but also by those who have long been connected with Professor Putnam through all the years of struggle to make anthropology a recognized field of scientific endeavor; and

Be it further Resolved, that these minutes be spread upon the records of the association and also be sent to the members of Professor Putnam's family.

RESOLUTION OF THE AMERICAN ANTHROPOLOGICAL ASSOCIATION RELATING TO THE DESIRABILITY OF RESUMING THE OPERATIONS OF THE ETHNOLOGICAL SURVEY OF THE PHILIPPINE ISLANDS

(Prepared by Edward Sapir and R. H. Lowie.)

The members of the American Anthropological Association have learned with great regret of the decision to suspend the operations of the Ethnological Survey of the Philippine Islands. The native populations of the Philippine Islands are among the most interesting of the globe from a scientific point of view. They include a pygmy race whose study will shed light on the physical anthropology and culture of one of the most primitive divisions of mankind. On a higher level a host of Malay tribes require investigation for the purpose of determining their relations with one another and with alien groups. In short, the Philippines offer an unusually rich field for important research which should not be left to the accident of private interest.

It is therefore respectfully urged by the American Anthropological Association that the proper authorities authorize the resumption of anthropological research in the Philippine Islands at the earliest opportunity.

On January 19, 1916, the secretary received a reply from Mr. J. L. Hunt, assistant to the chief of the Bureau of Insular Affairs (War Department), from which the following is taken:

"Anthropological work which has been carried on in the Philippine Islands has not been done by the federal government or maintained at federal expense, but has been carried on by the Philippine government through its Bureau of Science. Some months ago the Philippine government found it necessary greatly to curtail its expenses on account of a considerable falling off in its revenues, and among other activities of the Philippine government which had to be suspended or discontinued were those in connection with anthropology.

"A copy of your letter is being transmitted with its inclosure to the governor-general of the Philippine Islands at Manila for consideration by the proper authorities there."

RESOLUTION FAVORING BILL TO DISCONTINUE THE USE OF THE FAHRENHEIT THERMOMETER SCALE IN GOVERNMENT PUBLICATIONS

WHEREAS, there is now pending in congress a bill, known as H. R. No. 528, to discontinue the use of the Fahrenheit thermometer scale in government publications:

Be it Resolved, that said bill have the support of the American Anthropological Association.

A vote of thanks to the regents and secretary of the Smithsonian Institution for the facilities so generously placed at the disposal of the association and for the reception at the National Museum was unanimously carried.

On invitation from Dr. P. E. Goddard, it was voted to hold the next regular meeting of the Association at the American Museum of Natural History, New York City, on December 27–30, 1916, in affiliation with Section H of the American Association for the Advancement of Science.

Nearly one hundred titles were offered in the joint program; with but few exceptions the author was present and read his paper. A large majority of the abstracts were presented through the International Congress of Americanists.

The Place of Archeology in Human History: W. H. HOLMES.

The term history as applied to the human race is a comprehensive designation corresponding with the term anthropology, which is defined as the science of man. The sources of information to be drawn upon in these researches are comprised under two principal heads: (1) intentional or purposeful records, and (2) non-intentional or fortuitous records. The intentional records are of five forms, as follows: (1) Pictorial, as in pictures and pictographs; (2) major objective, as in commemorative, monumental works; (3) minor objective, as in *quipu* and *wampum;* (4) oral, as in tradition and lore; (5) written, as in glyphic and alphabetic characters. With each of these categories goes necessarily a mnemonic element—a very considerable dependence upon memory. Fortuitous records take numerous forms: (1) The great body of products of human handicraft to which no mnemonic significance has ever been attached; (2) the non-material results of human activity as embodied in language, beliefs, customs, music, philosophy, etc.; (3) the ever-existing unpremeditated body of memories which accrue to each generation and are in part transmitted adventitiously; (4) the record embodied in the physical constitution of man which, when properly read, aids in telling the history of his development from lower forms; (5) the records of intellectual growth and powers to be sought in the constitution of the mind; (6) the environments which may be made to assist in revealing the story of the nurture and upbuilding of race and culture throughout the past.

It is from these diversified records, present and past, that the story of the race must be derived. Archeology stands quite apart from this classification of the science of man, since it traverses in its own way the entire field of research; howbeit, it claims for its own more especially that which is old or ancient in this vast body of data. It is even called on to pick up the lost lines of the earlier written records, as in the shadowy beginnings of glyphic and phonetic writing, and restore them to history. It must recover the secrets of the commemorative monuments—the tombs, temples and sculptures intended to immortalize the now long-forgotten great. It must follow back the obscure trails of tradition and substantiate or discredit the lore of the fathers. It must interpret in its way, so far as interpretation is possible, the pictorial records inscribed by the ancients on rock faces and cavern walls, these being among the most lasting and purposeful records. All that archeology retrieves from this wide field is restored to human knowledge and added to the volume of written history. Archeology is thus the great retriever of history.

The Origin and Destruction of a National Indian Portrait Gallery: F. W. HODGE.

Description of the efforts made in the early years of the last century to establish at Washington a national gallery of Indian portraits, particularly the part taken therein by Thomas L. McKenney, superintendent of Indian trade and later in charge of the Office of Indian Affairs. The growth of the collection; the artists engaged in the task; the use of the portraits in illustrating McKenney and Hall's elaborate and expensive work on the Indians; the transfer of the collection to the National Institute and later to the Smithsonian Institution; the addition of the loan collection of Indian paintings by J. M. Stanley, and the final destruction of almost the entire collection by fire in 1865.

Indications of Visits of White Men to America before Columbus: WILLIAM H. BABCOCK.

Ancient writers and voyagers knew the Atlantic as far west as Corvo and the Saragossa Sea, approximately half-way to America, and some of them describe or mention a continent on the western side of that ocean; but these statements lack distinctive touches which might serve as tests of reality.

Medieval maps and Norse sagas give reason to surmise that early Irish mariners reached the northeastern outjutting elbow of America surrounding the Gulf of St. Lawrence, which they called Brazil. This would probably be considerably before the Norse arrival in Iceland near the close of the ninth century, for the Norsemen found that Irish monks had preceded them there.

About 985 Eric the Ruddy of Iceland planted a colony in Greenland, which survived for 450 or

500 years. In the year 1000, according to the more credible form of the saga, his son Lief discovered Vinland or Wineland, otherwise the mainland of America. His sister-in-law, Gudrid, and her husband, Thorfinn Karlsefni, explored a part of the American coastline, about the years 1003 to 1006, but failed in the attempt to establish a permanent settlement. Mainland America was probably repeatedly visited from Greenland and Iceland. One such visit is recorded positively as occurring in 1347.

Before 1367 a Breton expedition met with partial disaster at an island farther south and west than the Brazil before referred to. It would naturally be some point on or off the lower American Atlantic coast line, possibly Cape Cod or the Bermudas. Many maps show this more remote island, usually of crescent form, and most often having the name Man (Mam) or Mayda.

Probably Behaim's globe of 1492 is substantially right in stating that a Spanish (Portuguese?) vessel sailed to Antillia in 1414. Beccaria's map of 1435 presents as "Newly reported islands" an insular group of four—Antillia, Salvagio, Reylla and I in Mar. These are repeated more or less completely on the maps of Bianco, 1436; Pareto, 1455; Roselli, 1648, the Weimar map sometimes credited to 1424, but probably Freducci's about 1481, Benincasa, 1482, and the Laon globe of 1493. They must be what Justin Martyr (1511) calls "The Islands of Antillia." Apparently the latter island was Cuba.

The 1448 map of Bianco shows a long coast line on the edge of the parchment opposite Cape Verde, with an inscription in a Venetian dialect, variously read as stating 1,500 miles for the interval or the length of shore. It would seem that some one may have anticipated the experience of Cabral in reaching South America by this route. The discussion of this point before the Geographical Society brought out an elaborate review of the Portuguese records of westward discovery by J. Batalho Reis, which presents many valuable items of western discovery. But there seems nothing in them clearly to indicate voyages to America before Columbus. Divers other claims have been made for Normans, Poles, Basques and Orkneymen, but are hardly to be trusted.

Vineland—Its Probable Location: A. GAGNON.

In what part of North America was Vineland located? The author attempts to throw some light on the question through the help of the sagas, which date from the twelfth to the fourteenth century, and which recount the earliest voyages to Greenland and Vineland.

Pan-American Topic: ADRIAN RECINOS.

The author considers of prime necessity the conservation of architectural monuments and of all objects belonging to the domain of archeology and anthropology, in order to be able to arrive at a clear notion of the pre-Columbian history of the Western Hemisphere. He believes it entirely feasible that the different American countries should pass uniform laws for the protection of antiquities, since the laws on this subject show great similarity in the different countries to-day. What he thinks has been lacking up to the present time in the different countries is a special legislation aimed to encourage systematic investigations in the field of archeology and anthropology. He believes it advisable that the American governments should agree that the existing museums and libraries in the respective countries should harmonize their work and exchange duplicate objects which they may possess.

Anthropology in the Museum of the Buffalo Society of Natural Sciences: HENRY R. HOWLAND.

From its organization in 1861 the Buffalo Society has been active in the collection and study of anthropological and ethnological material, in which direction its collections and publications are especially noteworthy. In late years its activities have been greatly increased and its archeological collections materially augmented by systematic field work and careful study of results. Mr. Howland's paper calls attention to the richness of materials for such investigation and study in western New York, where, in pre-historic and early historic days, the aboriginal inhabitants were notably the Indians of the Neutral Nation, the Wenrohronons, and southward and westward of the Niagara frontier, the people called by the Jesuits the "Nation of the Cat." All of these ancient sites, burial places, etc., have been critically examined and studied by the Buffalo Society, and the results, with maps, etc., published in a bulletin of 150 pages in 1909.

A later bulletin described by Mr. Howland covers rich results of field work carried on further eastward where those large Seneca towns were destroyed by the French Governor Denonville in 1687. Another bulletin is now ready for the press in which are traced the early migrations of the Seneca before their discovery by white men.

Mr. Howland briefly calls attention to the large educational work which has been carried on by the

society for many years, correlating its work directly with the public school system of Buffalo to an extent not attempted elsewhere, and predicts for the future extended work in anthropology as well as in other branches of natural science.

Excavation of a Pre-Lenape Site in New Jersey: E. W. Hawkes.

Few regions in North America are of greater interest archeologically than the north Atlantic seaboard as throwing light on the possible antiquity of man in America. Particularly in the Trenton area we find evidence of two culture levels—that of the modern Delaware Indians and an argillite culture which has been the subject of much dispute. During last summer the author and his colleague, Mr. Ralph Linton, made an excavation of an Indian site near Moorestown, New Jersey, which promises to throw some light on the comparative age of the two cultures.

Modern Indian implements were found in the upper stratum of leaf mold, six inches deep; argillite implements of an intermediate type in the center of the next stratum, a layer of yellow sand, five to seven feet deep; and, at the juncture of the yellow sand with a stratum of white glacial sand, extensive remains of a ceremonial site were uncovered, which consists of caches of argillite points and bannerstones grouped in three more or less parallel rows around a great central fire-pit. The fire-pit had blackened the layer of white sand for two feet down, but showed no trace above, thus proving conclusively that the material of the two layers was clearly separate.

The probable age of the levels rests in the geologic formation of the site, which was in the shape of a mound. If laid down in water, which is geologically probable, the points from the lowest level would belong to glacial times; if wind-blown, which is more probable, the argillite implements would be comparatively recent. The presence of bannerstones among them would appear to be an argument against any great antiquity. The number of types of argillite implements found extends the limits of this culture, but raises the broader question of whether it was continued into a more modern era than has been supposed to date.

Excavations on the Abbott Farm at Trenton, New Jersey: Clark Wissler, C. A. Reeds, and Leslie Spier.

This report is on one phase of a systematic investigation of the chronological relations of Coastal Algonkin culture. Mr. Alanson Skinner will report separately on another aspect of the problem. In the course of their local field-work the writers encountered traces of what seemed to be the argillite culture described by Volk and Abbott as found in the yellow drift at Trenton. Artifacts were found in the yellow drift at a few other points near the terminal moraine, sites that will be excavated in the near future. For the sake of comparative data, and since the Trenton site is about to be destroyed by railway extension, considerable attention was given to it. The problem for the next few years will be the study of the yellow drift deposits farther north. This report will deal almost entirely with the site on Dr. Abbott's farm at Trenton.

A. Archeological Report, by Leslie Spier.—Data are offered in support of the following: The excavations so far made in the yellow drift of the Trenton district have yielded artifacts in quantity sufficient to warrant the conclusion that typical conditions are here represented. The artifacts are culturally distinct from those of the Delaware Indians found in the surface soil. They are distributed throughout the site, lying in a characteristic manner in the upper portion of the yellow drift, and entirely separate from the artifacts in the surface soil. They have not penetrated the yellow drift from the surface soil above, but bear an intimate relation to the geological structure of the drift.

B. The Application of Statistical Methods to the Preceding Data, by Clark Wissler.—It is shown that the tabulations of artifacts and pebbles from the several trenches give typical frequency curves. Also that they are in each case component parts of a single series. There is here the suggestion of a new departure in archeological method, or rather the introduction of the methods of precision used in many other sciences.

C. Geological Report, by Chester A. Reeds.—The geologic history of the Trenton district is long and varied. The triassic overlap on the rocks of Cambrian and pre-Cambrian age extends from Trenton northwestward. The marine beds of the Cretaceous, Tertiary, and early Pleistocene periods overlap on the Triassic rocks along a line from Trenton to New York. During late Glacial and post-Glacial times the drainage was in part normal to and in part parallel to this line. The streams of to-day occupy the same relative positions as they did in late Pleistocene times, but their valleys have been modified somewhat by subsequent corrasion and aggradation. In the comparatively recent geological past deposits containing artifacts

were made on the delta of Assanpink creek. At the present time these deposits occupy a position about sixty feet above the flood plain of Delaware river. Most of the artifacts which have been collected come from the Lalor and Abbott farms just to the south of Trenton. In the Trenton Folio of the U. S. Geological Survey the bed containing the artifacts, referred to locally as the "yellow drift," has been mapped with the Cape May formation. The geologic development of the Trenton district is treated briefly and is followed by a discussion of the topography, drainage, valley sculpturing, and geologic age of the terrace deposits. The petrologic character of the material from the trenches is also considered, as well as the red band deposits which have been found in the artifact-bearing sands.

Archeological Work in Northern Nova Scotia: HARLAN I. SMITH.

The archeological work in northern Nova Scotia, carried on for the Geological Survey of Canada, was chiefly in the shell-heaps of Merigomish harbor, and resulted in obtaining perhaps the most complete and detailed data thus far secured regarding the archeology of Nova Scotia, as well as one of the three largest collections of Nova-Scotian specimens. No burials were discovered. These shell-heaps are situated usually in the most sheltered places, generally on southern shores; and on islands rather than the mainland, although there are some small heaps on the latter. The sites are above high tide, but usually on low places sheltered from the wind by bluffs. They are probably the remains of Micmac villages. Chipped points of stone for arrows, celts of stone, pottery, and sharpened bones were very numerous. Little knives or chisels, made from beaver teeth, harpoon points of bone, and other artifacts were frequently found. Gouges were entirely absent, although common enough from Nova Scotia, and represented in some collections by about as many specimens as there are of celts. On the whole the quantity of specimens found in the shell-heaps was much less than would be found in some village sites in southern Ontario.

Remarkable Stone Sculptures From Yale, British Columbia: HARLAN I. SMITH.

Several remarkable stone sculptures, found near Yale, British Columbia, are kept in private collections, but have been photographed for the Geological Survey of Canada. They are among the most striking archeological sculptures known from Canada.

The Culture of a Prehistoric Iroquoian Site in Eastern Ontario: W. J. WINTEMBERG.

The inhabitants of the Roebuck site, a prehistoric Iroquoian palisaded village site in Grenville county, Ontario, explored for the Geological Survey of Canada in 1912 and 1915, appear to have been a peaceful agricultural people. Most of the artifacts are those usually found on Iroquoian sites in Ontario and New York state. Chipped stone points for arrows and spears are scarce, although those made of bone and antler are common. Unilaterally and bilaterally barbed bone and antler points for harpoons, and barbed fish-hooks made of bone, were found. Some of the pottery vessels had handles. Awls are the most numerous objects made of bone. A perforated wooden disk was found in the muck surrounding a spring. Pieces of carbonized rope or cord and a carbonized coarse fabric are the only textiles recovered. Beads are of bone, shell, stone, and pottery. Pieces of human skull were fashioned into perforated round gorgets. A few pieces of stone gorgets were also found. Rubbed and also hollowed phalanx bones of the deer, and disks rubbed and chipped from stone and potsherds, were used probably in playing games. Some large awls or daggers were made of human ulnæ. Fragments of pottery pipes, some having modeled human faces and animal heads on the bowls, are numerous. Stone pipes are scarce. Some pipes are made from deer scapulæ. A phallus carved from antler was also found. Eighty-three skeletons were exhumed. Judging from the condition of stray human bones, ceremonial cannibalism may have been practised.

Prehistoric Sites in Maine: WARREN K. MOOREHEAD.

The department of archeology of Phillips Academy spent five seasons in the exploration of ancient and modern Indian sites in Maine and New Brunswick. The maps covering the regions visited record more than three hundred places where former aboriginal occupancy is in evidence. The purpose of the work in Maine was to indicate the evidence of aboriginal occupancy and to determine whether the sites represent more than one culture. Sites occupied by various divisions of the Algonquian stock appear to be common, and range from those indicating contact with Europeans to others which appear to be prehistoric.

Occupying an area of approximately one hundred and fifty by one hundred kilometers in the central southern portion of the state are certain cemeteries or deposits of peculiar artifacts, accompanied by large quantities of brilliant red ochre or

hematite. As there is no historical reference to the people responsible for this culture, the term "Red Paint People" is offered. Nineteen of these deposits or cemeteries have been found—three by Harvard University, six by citizens of Maine, and ten by the Phillips Academy survey. The contents of these Red Paint cemeteries or deposits represent limited and fixed types, most of which do not occur on the surface of village sites, and are absent from the shellheaps on the coast of Maine. The ochre or hematite occurs in large quantities in central Maine at the Katahdin Iron Works, where there is an iron outcrop.

In the Red Paint deposits occur no pottery, pipes, crude axes, or hammers. Adz blades, gouges, long, heavy perforated stones, "plummets," slender slate spears, and kindred types predominate. The persistence of these seven or eight types is remarkable, and differentiates these graves from all others in Maine. Twenty per cent. of the stone implements show disintegration, which may be due to chemical action of the ochre in contact with the tools.

While it has been thought that this culture extends toward the east, the exploration conducted in the summer of 1915 indicates that there is a gradual change in the types on Georges river, which is the westernmost point the survey has reached. The author, therefore, gives it as his opinion that the types will be found to merge with the Algonquian in western Maine.

Brief comparative reference is made to the shellheaps along the Maine coast. In conclusion, the author refers to the Beothuk traditions and descriptions cited by early voyagers in Newfoundland. Whether the sites of the Red Paint people will be found east of the mouth of St. John River in New Brunswick will be determined after that region has been explored. The author shares with the late Professor F. W. Putnam and Mr. C. C. Willoughby the belief that the Red Paint culture is one of the oldest in the United States.

Explorations of the Mounds and Caverns of Tennessee: W. E. Myer.

An extensive Indian town at Castalian Springs, Tennessee, was explored. This settlement covered about fifty acres and consisted of five mounds, a line of embankment, and a large stone-grave cemetery. One of the smaller mounds contained more than one hundred stone-grave burials and yields many examples of aboriginal workmanship. Many of the ornaments, while of local make, seem to show the influence of Mexican culture. The graves yielded many traces of curious and unique customs, such as the burial of two or more bodies in one coffin; the raking to one side of the bones of a former burial and placing a new body in the coffin; the burial of fleshless bones in bundles; the burial of crania unaccompanied by other bones, in small stone boxes; the burial of children with adults in such positions as to arouse suspicion that the child may have been placed in the grave alive. One author explored many of the caverns and rock-shelters of the Cumberland valley, which will be described and illustrated.

The Wesleyan University Collection of Antiquities from Tennessee: George Grant MacCurdy.

The collection in question was gathered by the late George D. Barnes in the vicinity of Chattanooga, prior to and during 1895. It is said to have come almost wholly from Williams island, in the Tennessee river, and largely from a single mound. The collection, which numbers several thousand specimens, was bought for Wesleyan University, Middletown, Connecticut, by Mr. A. R. Crittenden of that city; and with the exception of the small portion sold to the Natural History Society of Marion, Massachusetts, is now in the Judd Museum.

Among the notable specimens are the shell gorgets. A large majority of these belong to the class in which representations of the rattlesnake play an important rôle. There are several so-called scalloped disks, one gorget depicting the human form, and a few mask-like shell ornaments.

Of special interest are the button-shaped ornaments of shell with two holes for fastening or suspension in the center of a squarish field. Similar objects were found by Mr. Clarence B. Moore in a burial urn from the grave of an infant at Durand Bend, Dallas county, Alabama. They were near the neck of the child as if they might have formed a necklace or been attached to a garment.

Wesleyan University is to be congratulated on having secured so many important antiquities from a given locality in Tennessee. It is, however, unfortunate that a prehistory of Williams Island could not have been written during the lifetime of Barnes (and of Loper, late curator of the Judd Museum). The case of this collection thus illustrates anew not only the desirability of expert scientific control in archeological excavations, but also the duty imposed on the collector to see that the results are published promptly.

Some Mounds of Eastern Tennessee: George Grant MacCurdy.

About forty-five years ago the Rev. E. O. Dunning, of New Haven, spent two or three seasons in excavating certain ancient mounds of eastern Tennessee. Part of this work was under the auspices of Peabody Museum of Yale University, and part under those of Peabody Museum of American Archeology and Ethnology at Harvard University.

Brief mention of Mr. Dunning's explorations and the collections he obtained is made in the Fifth Annual Report of the Sheffield Scientific School of Yale College; and in the Third, Fourth, and Fifth Annual Reports of Peabody Museum at Harvard. Dunning does not seem to have left any notebooks or drawings and plans as a result of his field-work. The original documents bearing thereon are thus confined to the specimens and to his letters preserved in the Yale and Harvard museums. Dunning's explorations covered parts of Knox, Jefferson, Hamblen, Greene, Marion, and Cocke counties, but were limited chiefly to the Brakebill, McBee, Lisle, Lick Creek, and Turner's mounds. Only the first three of these are represented in the collections at Yale; and to them the present paper is confined.

A comparative study of the gorgets found by Dunning in the aforementioned mounds, and those in the Wesleyan University collection, leads the author to the conclusion that the so-called scalloped disks and the gorgets representing the cross are but conventionalized varieties of the realistic rattlesnake gorget. The kinship would be even more apparent were it not for the incompleteness of the record, and the gradual exaggeration and stereotyping of small differences due to conventionalism.

The Archeology of the Ozark Region of the United States: CHARLES PEABODY.

Throughout the region of the "Ozark Uplift" in the states of Missouri and Arkansas are many caves of which a great number have been occupied by prehistoric man.

In the soft deposits (occasionally brecciated) within, are found projectile points and knives, scrapers, perforators, nuclei, and other specimens in stone, pins and awls of bone, rare fragments of pottery, and in a few instances human bones; animal bones are abundant.

The culture as a whole is distinguished from that of the supposedly contemporaneous occupations in surrounding regions by the lack of problematical forms, of elaborate pottery and of careful burials.

The reason for this is not yet clear; the time of occupation of the caves must have been long; whether the occupants were the same tribes as those surrounding, or different, has not yet been determined; neither the theory of "summer resorts" for the lowland Indians nor that of a quite independent occupation seems adequate.

Early Pueblo Indian Missions in New Mexico: L. BRANFORD PRINCE.

The fame of the Franciscan mission churches in California has obscured the history and description of those in New Mexico, and yet the latter are in many respects the more interesting and important. They are very much older and there is far more variety in their history. The earliest California mission was built in 1769, and the story of one is practically the story of all. In New Mexico each mission has its individuality; the first mission was built in 1598, immediately after the colonization, and at least twenty-five were established before 1630. The massive mission structures, whose remains are seen at Abo, Cuara and Tabira, and constitute the most striking historic ruins in the United States, were built, had fulfilled their religious mission, and were finally deserted, before 1679. The peculiar feature of the heavy walls, composed of small, thin stones, is essentially aboriginal and similar to that of a number of the great prehistoric ruins in the Pueblo Bonito and San Juan regions. One remarkable circumstance connected with these massive walls is that they were constructed entirely by the Indian women, in accordance with the then uniform Pueblo custom, as distinctly stated by Benavides in his memorial to the King in 1630.

Archeology of the Tano District, New Mexico: N. C. NELSON.

The American Museum's Southwest Archeological Expedition, which entered the field in 1912, has just finished its contemplated work in the Taño Pueblo district of New Mexico. The region under investigation lies between the Rio Grande and Pecos River, with Santa Fé on its northern border, and covers an area of about 1,600 square miles. Within these limits were located 46 pueblo ruins, some small and some very large, besides numerous small houses and minor sites of archeological interest. Twenty-six of the most important sites were tried out by excavation, about 2,000 rooms being cleared, in addition to a very considerable amount of trenching in refuse heaps and burial grounds.

The results have been gratifying in several respects. About 3,500 artifacts of stone, bone, shell,

wood or fiber, and clay have been added to the Museum collections; and twice that number of common objects, such as mealing stones and the like, were left on the field. Comprehensively stated, the data obtained are of such a character as to warrant the separation of the various ruins into six successive chronological groups, the last two of which are of historic date.

Prehistoric Cultures of the San Juan Drainage: A. V. Kidder.

Omitting non-sedentary tribes, the remains are divisible into three groups. (1) *The Kiva Culture* is the latest; to it belong majority of cliff-dwellings and pueblos of the region. The kiva is a constant feature of the ruins. The problem of interrelation of the ruins and chronological sequence is complicated and best approached by preliminary classification of the remains at present known. There are several well-defined groups: Mesa Verde, Montezuma Creek, Chaco Cañon, Chinlee, Kayenta; also numerous ruins both in and outside these groups which can not yet be classified. Each group is characterized by peculiarities in pottery, architecture, and kiva construction.

(2) *The Slab-house Culture;* closely allied to the kiva culture and may belong to same. Range is not known; so far definitely recorded from but a single locality in northeastern Arizona, where it underlies kiva culture group. Rooms semi-subterranean, of slabs and adobe; apparently no true kivas, and pottery distinct from that of the later ruins of the region.

(3) *The Basket-maker Culture;* probably the earliest of the three. First reported from southeastern Utah. The basket-makers were cave-dwellers, built no stone houses and made little pottery. The textile arts were very highly developed, and they appear to have had several implements not used by the later inhabitants.

The interrelationship of these three cultures can not be determined without much more field work.

Notes on Certain Prehistoric Habitations of Western Utah: Neil M. Judd.

During May and June, 1915, an archeological reconnaissance of several valleys in western Utah was made under instructions from the Bureau of American Ethnology. Limited excavations at a number of widely-separated localities revealed the structural characteristics of the house remains at each site and gave some indication of the cultural attainments of their ancient inhabitants.

An examination of several mounds near Willard, on the northeastern shore of Great Salt Lake, disclosed the ruins of dwellings which must have resembled very closely the well-known winter hogan of the Navaho Indian. Other shelters of the same type were found at Beaver City, in close proximity to rectangular dwellings of adobe; mounds at Paragonah, in Iron County, covered walled habitations similar to the larger structure near Beaver. At the two last-named localities a majority of the ancient dwellings had been single-roomed houses, more or less closely associated with each other. Near Kanab, in Kane County, photographs and measurements of a small cliff-village, consisting of a kiva and four unconnected rooms, were made.

Excavations at these several localities resulted in small collections of archeological material that, like the structures from which they were obtained, seem to point to a cultural relationship between the builders of the three types of primitive dwellings here mentioned.

Notes on the Orientation of Ancient Pueblos, Reservoirs and Shrines in New Mexico: William Boone Douglass.

Description of the ruin area around the communal building known as Puye, on the Jemez plateau, which was carefully surveyed, and the various buildings mapped to show their orientation and grouping. The orientation of Tshirege and Tyuonyi (communal houses of the Jemez plateau) and of their accompanying antiquities is given and a comparison made with the orientation of a Tewa pueblo of the historic period.

Notes on Shrines of the Tewa and other Pueblo Indians of New Mexico: William Boone Douglass.

(1) A detailed description of the "World Center shrine" on Tsikomo peak of the Jemez Mountains, with a reconstruction of the shrine, in which are used the offerings taken from it. (2) A full description of the shrines of La Sierra del Ballo, and the exhibition of a silver ornament taken from one of them. (3) A brief description of the nine shrines of Tonyo, the sacred mountain of the San Ildefonso Indians, to which they retreated and successfully resisted the Spanish invaders during the Pueblo rebellion of 1680–1692. (4) The Cloud shrine and the War God shrine will be briefly described, with reference to the offerings found in them.

George Grant MacCurdy

(*To be continued*)

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE TEACHING OF CLINICAL MEDICINE[1]

THE SCIENCE OF CLINICAL MEDICINE

CLINICAL medicine is the most complex of all the natural sciences, for successfully to study it one needs to be more or less familiar with the content and the methods of investigation of a whole series of ancillary natural sciences (physics, chemistry, biology, anatomy, physiology, psychology, physiologic chemistry, pharmacology, pathologic anatomy, pathologic physiology, bacteriology and parasitology, immunology, etc.). Like other natural sciences, clinical medicine consists of a growing accumulation of truths that make up a more or less distinct body of knowledge. In order that this body may be conveniently organized, the facts of the science have to be collected, compared with one another, arranged in logical sequence, and, as far as possible, summarized in the form of generalizations known as laws or principles. The many ways of accumulating and organizing the facts pertaining to the sick constitute the scientific method of internal medicine.

Studies of patients have shown us that the transformations of matter and energy in the bodies of the sick, though conforming to natural law, deviate to a certain extent either qualitatively or quantitatively from the transformations in health. Workers in clinical medicine are gradually finding out how to detect these deviations from the normal by systematic inquisition of the minds and bodies of their patients. They

[1] Read at the meeting of the Association of American Medical Colleges, Chicago, February, 1916.

began their studies by using the method of simple observation, but they have learned how to make observation more accurate by experiment so that internal medicine has now become an elaborate experimental science. The study of a single patient by modern methods includes the making of a very large number of experiments, that is, of test procedures adopted on the chance of their yielding to observation under especially controlled conditions definite information that is not obtainable by simple non-experimental observation. There is no other science in which the technic of accumulating facts is as extensive as in clinical medicine, for its methods of examination are based on and include the technical methods of the preliminary natural sciences and of all the intermediate, simpler preclinical sciences.

The end, or goal, of clinical medicine is to understand the abnormal conditions that may occur in the human organism in order that physicians may act in a rational way to cure them or to prevent them, instead of being content to act in the blind and haphazard way of the ignorant. The collection of data, the arrangement of them according to their similarities and sequences, the epitomizing of them in the form of brief symbols or generalizations such as syndromes or disease complexes, while important in themselves for the construction of the science, are in reality only means to the larger end of permitting suitable action for the welfare of human beings that entrust themselves to the care and supervision of the medical profession.

The great *science of clinical medicine* is, therefore, subdivisible into two large parts: (1) That dealing with the understanding of exactly what is going on in the body and mind of the patient and how it has come to pass—the *science of diagnosis;* and (2) that dealing with the fitting action to be taken to prevent the origin or extension of abnormal processes, and, when possible, to restore bodies and minds deviating from normal function to a healthy state—the *science of prophylaxis and therapy.* We endeavor to *know* in order to be able to *predict* and to gain the power to *control.*

The imperative need of the clinician to know in order rationally to act has accounted for the origin of the whole group of the natural sciences. For, as every one knows, physics, chemistry and biology had their birth as a result of this need felt by physicians; these sciences, and each member of the whole group of the preclinical medical sciences, began as daughters of the clinic. In their infancy they were under the fostering care of medicine; but they have grown up into lusty adults, and now, many of them, besides contributing handsomely to maternal support, are rendering notable service to human efficiency and culture in domains far removed from clinical medicine. I mention the primary relationship, for some understanding of it is of importance for the planning of clinical teaching.

The Nature of Clinical Teaching

If the definition of clinical medicine that I have given be accepted, the nature of the teaching will be readily understood. It will consist (1) in *instructing* the students regarding the organized body of knowledge that has been accumulated concerning diagnosis and therapy (as already broadly defined); and (2) in *educating* them in the methods used in accumulating facts, in arranging them, in comparing them, in epitomizing them, and in acting in a rational way afterward—preventing, curing and mitigating.

On these general principles as a foundation, the teachers of clinical medicine have to construct a suitable concrete curriculum

for the clinical years, in planning which every effort should be made to parcel out the precious time, and to fill the periods, in such a way as to give the best opportunities possible, under the teachers and with the equipment available. It is desirable that the students shall gain a comprehensive knowledge of the principles of clinical medicine and a systematic schooling in its practical-technical methods, both of which are necessary for a medical career that shall be satisfying to the man and of adequate service to society.

THE STUDENTS AS THEY ARRIVE IN THE CLINIC

Fortunately, students now enter the clinical years, or should do so if they take advantage of the opportunities offered them, habituated to the method of science. They have become familiar with the general principles of the three great preliminary natural sciences (physics, chemistry and biology) and of the three great preclinical medical sciences (anatomy, physiology and pathology), and to a certain extent they have been trained in the actual use of the practical-technical methods of investigation employed in the laboratories of these six sciences. By the time they have reached the clinics, we may assume that they know what the scientific method of inquiry is. We may take it for granted they have learned how problems are set and solved, that they have acquired a feeling for accurate observation, for the critical sifting of facts, and for resorting to experiment to perfect their observations. Students thus trained will enjoy considerations of comparison and of regularity of sequence. They will be acquainted with libraries and will know how quickly to consult sources. Many of them will have learned properly to doubt when convincing evidence has not been brought, whereas they will also, through their experiences, have found that they may confidently act, after inquiry has shown that action can be taken along lines of sequences known to be invariable.

The student's knowledge of man and of his relations to the rest of nature should by this time be fairly large. The student knows man as a living, thinking, feeling, acting social organism, very much like other living beings, and yet differing strangely from them. He has opened the body of man after death and knows what his organs, tissues and cells look like to the naked eye and under the microscope, and he remembers how these have all gradually grown from the fused germ cells. He has had a glimpse of the materials of which the cells and juices of man's body are composed, has isolated some of these materials and studied their properties and origins. He has found out that the materials in man are constantly undergoing change, that with these changes, synthetic and analytical, remarkable transformations of energy go on, under special conditions it is true (colloidal states; ferment-activities, etc.), but always in obedience to the laws of the conservation of mass and energy. He has been fascinated by the study of processes known as irritability, contraction, circulation, respiration, secretion, digestion, absorption, metabolism, excretion and reproduction. He has seen how these various functions can be modified by environmental influences, and has come to look on the body and mind of an organism at any given moment as the direct resultant of the energies in the germ cells and the energies that have acted upon the organisms from without from the time of germ-cell fusion until that moment. He has come to see that what we call "disease" is modification of structure and function beyond certain limits, whereas maintenance of structure and function within these limits is designated as "health."

In the bodies of men dead of long-con-

tinued disease, he has studied the coarser and finer changes in the organs and in the cells, and has contrasted them with the findings in a healthy man of the same age killed by accident. His teachers have shown him specimens illustrating transition stages between coarser structural changes and the beginnings of organic disease. Studies of pathologic chemistry have convinced him that, in the absence of changes in form recognizable by our present methods, deviations of the chemical composition from that of health can often be found. Among the many deleterious environmental influences, he has discovered bacterial and parasitic invasion to be especially important; he has studied these bacteria and parasites, and has used them to produce diseases in animals for experimental comparative study. He has observed striking differences in susceptibility to noxæ among these experimental animals, and has seen that this susceptibility is capable of artificial modification. His studies in immunology and in pharmacology have convinced him that man can often intervene in a strictly rational way favorably to modify the processes that go on in an organism.

During this whole period of preliminary and preclinical study, the student's background has been gradually and extensively elaborated. His studies in each successive science have been, to a certain extent, a review of the sciences preceding. *Repetitio est mater studiorum.* And yet, even more important for the clinic than the actual content of the student's mind as regards the ancillary sciences is the long discipline that his mind has had in observing and reflecting —I mean, the development in it of a permanent scientific habit.

Medical Wards; Ambulatorium; The Institute for Clinical Medicine

The teaching of clinical medicine as a science demands conditions very different from those that formerly existed, and very different from those that are even at present available in any of our medical schools, though some schools have been fortunate enough to secure conditions that approach what is needed. Briefly stated, the conditions that a department of clinical medicine should control include (1) a medical clinic to which may be admitted a sufficient number of patients suffering from all varieties of both acute and chronic internal diseases (infectious, parasitic, respiratory, circulatory, hemopoietic, digestive, urogenital, locomotory, nervous, metabolic), with ward laboratories for routine application of the commoner laboratory methods; (2) a medical dispensary or ambulatorium, to which a large number of patients, who, for various reasons, do not enter the stationary clinic, apply for diagnosis and treatment, and in connection with which there are large and small teaching rooms, a laboratory and also quarters in which the various special branches of internal medicine apply their special methods of examination; (3) a large clinical institute adjacent to the wards and dispensary, containing (*a*) a clinical amphitheater for lectures, clinics and lantern-slide demonstrations to a whole class; (*b*) a general clinical laboratory in which systematic courses in clinical chemistry, clinical microscopy, etc., can be given to the whole class at the beginning of their clinical work; (*c*) a series of smaller laboratories especially equipped for routine work in clinical bacteriology, clinical immunology, clinical physiology, etc.; (*d*) other laboratories for advanced investigative work in metabolism, for the study of materials from clinical autopsies, and for animal experimentation; (*e*) a "heart station" in which sphygmographic and electrocardiographic and other graphic registrations can be made; (*f*) a capacious roentgenologic laboratory with complete outfit for modern roentgenography and

roentgenographic studies; and (*g*) many small rooms for special examinations with instruments of precision (ophthalmoscope, pharyngoscope, laryngoscope, esophagoscope, cystoscope, etc.), for members of the staff, for advanced students (undergraduate or graduate), for an artist, for photography, for technical assistants, for clinical records and for supplies. The institute should also contain at least a small departmental library for immediate reference; though for books and journals not daily in use the general library of the medical school and hospital will suffice.

THE INSTRUCTION AND EDUCATION OF THE STUDENT IN THE METHODS OF CLINICAL DIAGNOSIS

At the very beginning of the clinical work, a few general lectures should be given to the students offering a bird's-eye view of the scope of the sciences of diagnosis and therapy, explaining the relation of these sciences to the student's earlier studies, discussing the nature of the undergraduate curriculum in clinical medicine, and giving the reasons for the arrangement of the courses in a certain sequence. The first year of clinical work should consist almost entirely of a systematic education in the *methods of clinical examination* of the normal and the diseased human being and of substances derived from normal and from diseased people. Some lectures and demonstrations will be necessary properly to coordinate this work and to determine its being done intelligently, but the education at this time will depend mainly on closely supervised personal work of the student in the study and practise of methods of history-taking and of physical and instrumental examinations of healthy people and of dispensary patients, and in the laboratory study of materials derived from healthy and diseased living persons.

In teaching history-taking, the various parts of the clinical history—*anamnesis, status præsens, catamnesis, epicrisis*—should be systematically described, and each student should be given opportunity for personally questioning dispensary patients and recording the anamnesis he obtains from each.

In teaching physical diagnosis, a fundamental course in the clinic, the physical principles involved should be succinctly reviewed and the application of these principles to diagnostic methods, especially to auscultation and percussion, should be thoroughly described and illustrated by a teacher of ability, one that has had a sufficient training in the science of physics himself, and also an extended clinical experience. This course in physical diagnosis will also be a course in medical applied anatomy; it should be illustrated by models, by dissected specimens and by sections of formalinized cadavers. The theoretical and demonstrative side of this course in physical diagnosis should run parallel to a strict drilling of the student in the practical-technical details of the methods of physical examination, small groups of students carrying out the several procedures themselves on fellow students or on dispensary patients (the latter perhaps paid a small sum) under the eyes of young instructors who see to it that skill in the technic is gradually acquired. At this stage, too, a course in chemical physiology, like that advised by Professor Lee, will be of great advantage to the student. Much time should be devoted to these practical courses—enough to ensure mastery of method and the confidence of the student in the reports that his sense organs make to him.

The general course in clinical laboratory work, properly given, is one of the most important courses given in the medical school. It should consist of three half-day exercises

in the laboratory, extending over a period of at least six months. With judicious selection, a large amount of ground can be thoroughly covered, each student learning and practising the best methods of the time for the physical, chemical and microscopic study of the urine, the gastric contents, the duodenal contents, the feces, the sputum, the blood and the fluids obtained by exploratory puncture. Many of the methods need only be done once, but certain of them should be practised under control until the student satisfies himself and his instructors that he has acquired skill and accuracy enough in the technic to permit him to participate, in his last year, in the actual investigation of patients, with recording of his results in the official records of the hospital. This extra practise will be especially necessary in quantitative chemical examinations of urine and stomach contents, in blood counting and hemoglobin-determinations, in differential counting of white blood cells in stained smears, in examinations of cerebrospinal fluid, and in agglutination and complement-fixation tests.

During this first year of clinical work, the student should also acquire the technic of a whole series of special and instrumental methods of examination. Hitherto, students have too often been led to think that these special methods are beyond the scope of the work of the general practitioner, that there is something mysterious about them, and that the technic of their use is the prerogative of specialists upon whose rights and privileges the general student of medicine dare not encroach. Now, I am convinced that this is a great mistake. I think it exceedingly important that the minds of students and of general internists should be disabused of this fallacy. Most of the methods are very easy to learn and apply, and these every student should actually learn and practise.

The mystery should be taken away from all these methods. Even if, later on, as a practitioner, he evoke the aid of specialists in his work, the student will find that the training he has had in the methods of the medical specialists, giving him an acquaintance with these means of diagnosis and the power to interpret their applications, will place him distinctly at an advantage over practitioners whose schooling has not included training in such technic. Thus, in my opinion, every student should at this period of his growth become acquainted with Roentgen-ray apparatus and the technic of roentgenoscopy and roentgenography as applied to the study of different parts of the body. In the clinical, bacteriologic and immunologic laboratories he should learn the clinical applications of bacteriologic methods (collection of materials; diagnostic examinations by microscopic and cultural methods, or by animal inoculations and virulence tests), and the application to the clinic of the doctrines and technic of immunology (clinical studies of agglutinins, bacteriolysins, hemolysins, precipitins, opsonins and ergins), with especial emphasis on, say, the Widal reaction, the Wassermann reaction, the Schick reaction and the tuberculin tests. Next might come training in special methods of studying the respiratory apparatus (rhinoscopy, pharyngoscopy, transillumination of the paranasal sinuses, laryngoscopy, a demonstration of the use of the bronchoscope and of exploratory puncture of the pleural cavity); such studies, supplementing the course in general physical diagnosis of the lungs and pleuræ, the course in the examination of the sputum, and the course in roentgenology of the thorax, bronchi, lungs, pleura and diaphragm, will be the best possible preparation for the investigation of the special diseases of the respiratory system to follow in the last year of the student's course. Similarly, the special methods

useful in investigating conditions in the circulatory apparatus may now be rapidly acquired.

It is not as though we were educating raw high-school graduates; the students that are arriving in the clinics now are accustomed to the use of instruments of precision of various sorts, and are familiar with the general mechanical, optic, acoustic and electrical principles underlying them; they can, therefore, acquire much more rapidly an acquaintance with and skill in the use of clinical instruments and graphic methods of registration than would be possible for students untrained in the natural sciences. Roentgenoscopy of the cardiovascular stripe, so helpful for examining the configuration of the heart and in the recognition of aortic dilatations, will present no difficulties to our clinical student, and he will be fascinated by the simplicity and precision of teleroentgenography, which has largely replaced orthodiagraphy and which serves as a salutary control of the results obtained on percussion of the relative cardiac dullness.

Even the precise methods of mechanical registration of the movements of the heart and blood vessels (sphygmography, cardiography), of the heart sounds (phonocardiography), of the electrical currents generated in the heart during its activity (electrocardiography), and of the pressure of the blood within the arteries and veins (sphygmomanometry or tonometry of the blood vessels) can be speedily acquired, for the student has already had at least a glimpse of them in the laboratory of physiology. Though as yet we do not know how to value the results clinically as well as we should like, the methods that have been devised for determining the functional capacity of the heart should also be demonstrated. The student thus trained at the beginning of his clinical angiological studies, in addition to training in the ordinary physical methods, should have no difficulty in his later studies in accumulating the data necessary for forming a diagnosis when confronted by a cardiac arrhythmia, an inflammatory or a degenerative cardiopathy, or a hypertensive arterial malady.

Turning to the special methods useful in investigating the digestive system, the student has a considerable technic to acquire in addition to the ordinary physical methods of examination of the viscera, and the laboratory studies of the secretions and excretions. Thus, instruction should be given in the methods of examining the teeth and gums, preferably by a dentist attached to the clinic. Dental caries, paradental infections with formation of blind abscesses at the roots of teeth, and pyorrhea alveolaris are now so important, not only for themselves, but also in their bearings on disease elsewhere in the body that students dare not be permitted to leave the medical school without knowing how they may be recognized by inspection, by percussion, and by special roentgenograms on dental films, so that dental aid may, when required, be obtained. Then the newer technic of examining the esophagus should be demonstrated, though it may not be possible to give the undergraduate student actual practise in the passage of esophageal bougies, in roentgenology of the esophagus or in esophagoscopy. The physical exploration of the abdominal viscera will be taught in the general course on physical diagnosis.

Actual practise in gastric intubation of the fasting stomach and of the stomach after a test diet, and actual experience in roentgenoscopy and roentgenography of the stomach and intestines after a contrast-meal and a contrast enema, should now, in my opinion, be required of all students. The roentgenologist of the clinic should have a large demonstration room that stu-

dents may visit; there they should see typical normal and pathologic roentgenologic findings serially displayed; moreover, a few systematic demonstrations of these should be made by the roentgenologist to the class, so that every student may become familiar with the roentgenographic appearances of conditions like idiopathic dilatation of the esophagus, filling defects due to ulcer or carcinoma of the stomach and duodenum, intestinal stasis, kinks, adhesions and other forms of intestinal obstruction, diverticula of the sigmoid, etc., and will know how to make use of the Roentgen-ray method for recognizing them.

The special methods of studying the pancreatic functions by examination of the duodenal contents (obtained by the duodenal pump), the feces, and the urine, will require but little time; the same applies to the special methods of examining the liver and the biliary passages and their functions. Instruction in digital exploration of the rectum and demonstrations of proctoscopy and of rectosigmoidoscopy should form a part of the course.

As regards the *urogenital* system, its examination dare not be omitted in the teaching of clinical medicine. This part of the body should be as systematically examined as is every other part, for otherwise conditions of great importance for the general medical diagnosis frequently will be overlooked. It may be desirable, however, for obvious reasons, to have certain parts of urogenital methodology taught in the surgical and gynecologic clinics. The teaching of methods of examining the urine, of physical and roentgenologic methods of examination of the kidneys, and of methods of testing the capacity of the kidneys to excrete certain substances, belong in the medical clinic; and if, for any reason, the other clinics do not demonstrate urethroscopy, cystoscopy, ureteral catheterization, pyelography, etc., the medical clinic would have to provide for this teaching.

As to the special methods of examination of the *bones, muscles and joints,* only brief instruction will be necessary in the medical clinic, since by custom those methods are usually very extensively taught in the surgical clinic, especially in its orthopedic subdivision. For a rounded view of clinical medicine, however, some attention to them is necessary in the medical clinic where examinations for pain, limitations of movement, Roentgen-ray examination, trichinæ in muscles, etc., may often have to be made. The examination of the skeleton is often very important for the internist as throwing light on the metabolic functions and especially on the functions of the endocrine glands. I shall not be surprised if, later on, all the patients entering a general hospital, except those of surgical emergency, will first be sent to the medical clinic for thorough diagnostic study, before being distributed to the surgical, gynecologic, urogenital or other special clinics for therapy should the diagnostic study reveal that the patient requires surgical treatment.

The teaching of *neurologic* and *psychologic methods of examination* should occupy enough time to enable the students to acquire competence in at least the main procedures of clinical medical inquiry. It is best to divide this work into three parts, the first part dealing with the methods of accumulating neurologic and psychologic data from the patient, the second part dealing with the utilization of the accumulated data for deciding on the site of any lesions or of any abnormal processes present in the nervous system (topical diagnosis), and the third part dealing with the considerations that permit the drawing of inferences regarding the nature of the lesions or of the

pathologic processes. Thus, in the first place, the student will be taught how to make accurate examinations of the senses and of the sense organs (cutaneous, deep, gustatory, olfactory, acoustic, vestibular and visual); of the motor functions and the reflexes; of the coordinating powers; of the capacity for speech, for writing and for other complex movements; of the functions of the smooth muscle and of the secreting glands; of the sphincters, and of the trophic functions. In this connection, certain applications of anthropologic methods of measurement may be practised, as well as the technic of roentgenologic examinations of the nervous system, skull and spine; that of lumbar puncture; and that of diagnostic electrical examinations of the muscles and nerves. The student will be taught at this time, too, how to examine the mental state of a patient, paying attention not only to the patient's consciousness as a whole, but also to the special powers of attention, of apperception, and of identification, to the affective life of the patient as revealed by his feelings, emotions and moods, and to his conative functions, often called "the will," and judged of by the person's behavior or conduct.

The second part of this instruction in clinical neurology will involve a review of the architecture of the nervous system and of the physiology of the several neuron systems (centripetal, centrifugal and associative), in as far as these subjects can be applied to localizing diagnosis; the student will quickly see the reasons for deciding whether the lesions present, or the pathologic processes going on, concern the peripheral nerves, the spinal cord, the medulla, pons or cerebellum, the mid-brain, the interbrain or the end-brain, and whether they are focal or diffuse, single or multiple.

And in the third part of the neurologic work, instruction will be given in the principles on which the diagnosis of the nature of a nervous disease is arrived at. The difference between the so-called "organic" and "functional" diseases of the nervous system will be discussed, and the student will learn the criteria for recognizing whether a given organic disease has been due to disturbances of development, of the blood supply, or of the nutrition; to toxic or infectious processes causing degeneration or inflammation; to trauma; to parasitic invasion; or to tumor growth.

Instruction in methods should include finally the procedures used for the *clinical study of metabolism*. After a brief review of the physiology of metabolism, the student should be taught the requirements of systematic metabolic studies. Though there may not be time to do actual practical work in the quantitative chemical analysis of foods and excreta, the organization of a modern metabolic study will be illustrated and the students will become acquainted with the manner of preparing a patient for such a study, with the periods of observation required, with the doctrine of "balance," and with the preliminary tests that may have to be made of assimilation, digestion and absorption. After this introduction, the methods of determining in man the metabolism of proteins, nucleins and purins, carbohydrates, fats, water, mineral substances and vitamines will be demonstrated. The different forms of apparatus for direct and indirect calorimetry will be described and the use of at least some of them actually demonstrated. Such a preliminary discipline in the practical-technical methods of metabolic study I regard as essential if the students are later in their course to proceed to the study of states of under-nutrition and over-nutrition, of the several amino-acid diatheses, of diabetes mellitus, and of gout, armed with the knowledge and technic that the science of

medical diagnosis has now made available. Teaching hospitals should take the lead in making suitable provision for these studies of metabolism that are now indispensable for satisfactory diagnostic and therapeutic work.

As an appendix to the doctrines of metabolism, the methods of investigating the disturbances of function of the *endocrine glands,* so interesting at the present time to all workers in internal medicine, should be taught. Aside from certain pharmacodynamic tests to be made with epinephrin, atropin, pilocarpin, etc., judgments regarding the activities of the several endocrine glands depend largely upon (1) observations of the general *exterieur* of the body (facies, height, bony skeleton, span, skin, hairs, mass and distribution of subcutaneous fat, shape of pelvis, appearances of the acra, and of the genitalia, teeth); (2) systematic metabolic studies; and (3) systematic studies of the functions of the autonomic nervous system. The main diagnostic facts in this active area of clinical medicine can be quickly assembled and given in concise form to the students; thereafter, they may apply them in their work in the wards to the analysis of endocrinopathic cases.

Practical Applications of the Principles and Methods thus Learned in the Actual Study of Patients Entering the Clinic for Diagnosis

The rather extensive propædeutic clinical training that I have just described should, I think, be undertaken and finished before the students take up the complete diagnostic study of single unknown cases.

Students may then enter the wards for a period of say three months of concentrated clinical study of patients, and though still under strict control become an integral part of the working force of the clinic. If the wards of the clinic are under the close supervision of a junior and a graded senior resident staff, and are also daily visited by professors and associate professors, there is no reason why students educated in the way mentioned may not make possible more exhaustive studies of the patients than could otherwise be made by the staff, while the students themselves are gaining an invaluable clinical experience.

During this period of the clinical clerkship, the student should spend practically his whole day in the medical wards and in the laboratories and library adjacent to the wards, very much as does the regular medical house officer. A certain number of beds—say three or four—are assigned to each student. When a new patient enters one of these beds, the anamnesis is taken by the student, who submits it to the resident house officer for criticism or approval. The student makes a general physical examination, the results of which he records for himself, though this record may or may not be incorporated in the hospital records. In any case, the student has had an opportunity of making a physical examination without prejudice and of recording a *status præsens,* and he later has opportunity to compare his findings with those of the resident staff and with those of the visiting physicians. Certain routine laboratory and instrumental examinations he makes at once and records the results in the history, so that any member of the staff on coming to the patient finds not only a complete anamnesis ready for him, but also some reports on the urine, the feces, the blood and the blood pressure. After a review of the anamnesis and of the general physical findings by a member of the senior resident staff, further steps to be taken in the diagnostic study are discussed and the decision arrived at concerning the series of examinations next to be applied. The stu-

dent accompanies the patient to the special examining rooms and assists with the technic of the roentgenologic, immunologic, ophthalmologic, urogenital and other methods of examination employed.

Gradually the data bearing on the case are accumulated. The student is asked his opinion of their meaning, and every effort is made to lead him to form his own independent ideas regarding (1) the structural changes that have occurred in the patient's body; (2) the pathologic-physiologic processes that are going on; and (3) the etiology and pathogenesis of the disease. To his surprise, the student often finds that, at first, he can not see the woods on account of the trees. He is confused by the wealth of abnormal findings the study has yielded. He is in doubt as to the relative importance of the several findings, and may have difficulty in seeing internal connections that exist. He does not know yet how to arrange the findings in logical sequence. He has had no experience in the epitomizing of a group of observations in the form of a so-called "syndrome." He is not yet an adept in the construction of a clinical (or pathological-physiological) picture. And this is as it should be. The student who begins his clinical studies by looking for ready-made clinical pictures or syndromes goes at his work at the wrong end. Only after long experience at clinical analysis is the synthetic work of syndrome-formation desirable or profitable. For working in the right way, he finds that what is called a syndrome is only a generalization, or kind of shorthand expression, to abbreviate description—for proper use, not for abuse.

Through the whole period of the patient's stay in the hospital, the student follows the case closely. The course of the disease is observed and recorded. Complications are watched for. Early erroneous impressions are corrected. The student goes to textbooks, monographs and journals in search of descriptions of similar cases.

When therapeutic measures are instituted, their effects are observed. Should surgical operation become necessary, a student knows it and is present to observe what is found. Should death occur, the student assists at the autopsy, makes histologic and bacteriologic examinations of the organs, and, later, attends the clinical-pathological conference at which the case is discussed by the professor of pathology and the professor of medicine. After the study of any case has been finished, the student writes down his final impression of the whole case, in the form of an "epicrisis."

It is a disadvantage to the clinical clerk to be responsible for over three or four patients at once. He should not be hurried or overburdened at this stage of his development. It is better that he study one patient thoroughly and read and reflect on the case carefully, than that he study superficially a dozen different patients. During a clerkship of three months he will have studied a number of patients in a careful way, and rubbing elbows with his fellow clerks in the ward will have benefited by their studies of patients nearby.

Moreover, at the daily ward rounds he hears staff and students discuss various cases, and at the amphitheater clinics, which he can now really begin to enjoy, he listens to the presentation of a case, or of a subject in its entirety, and revels in the beauty and artistry of the clinical pictures that the experienced clinical teacher finds it possible and legitimate to compose.

In the clinics he hears also the results of the original inquiries that are under way, and if he has an original mind, the atmosphere of the clinic may incite in him visions of some new application of an ancillary science to the solution of some clinical prob-

blem and the desire to make a trial of it. Such a student will be very sorry when his clerkship in the clinic comes to an end.

Were the time of undergraduate medical study longer, the student could profit by attending special courses on clinical medicine in which a single group of diseases is intensively treated, say those of the digestive system, etc. Such courses should be offered in every medical center. They should be optional for medical students, not obligatory, and should be opened to physicians that apply to the medical clinic for "continuation courses." It may be that, sometime, as Professor Ewing has advised, we may add a fifth year to the medical curriculum, in order that more of this training may be given.

During his first year of clinical work, the student should study carefully a text-book of clinical methods of investigation; during his second year of clinical work he should study a good text-book of medical practise, in which both the diagnosis and treatment of internal diseases are dealt with. Such texts replace, to a large extent, the formal systematic lectures that formerly were given on medicine in the medical schools.

Above I have dealt only with the development of the teaching of the science and art of diagnosis. The teaching of clinical medicine includes, of course, that of therapy, and it, in my opinion, should be taught in a similar way, that is to say, first by a thorough education in the principles and technical methods of therapy, general and special; and, second, by first-hand experience in the application of these methods to the actual treatment of patients during the clinical clerkship. Unfortunately, the medical wards of our hospitals are all too often mere diagnostic institutes, unprepared for the teaching and application of therapeutics. It seems to me very desirable that each university medical clinic should have associated with it, not only an institution for clinical diagnosis, but also an institute for therapy, in which the methods of modern therapy may be systematically taught and applied.

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OUR UNIVERSITIES[1]

Such an organization as the American Philosophical Society represents a body of men who are keenly interested in the important problems that confront our universities. In my judgment, among the most significant problems we are facing to-day are the following: (1) the relation between instruction and research; (2) the relation in research of pure and applied science; and (3) the relation between university work and the modern commercial doctrine of efficiency. I wish to formulate a statement which will involve these three questions.

The research function of a university is its greatest function. In biological terminology it may be said to represent the central nervous system of the university organism. It stimulates and dominates every other function. It makes the atmosphere of a university, even in its undergraduate division, differ from that of a college. It affects the whole attitude toward subjects and toward life. This devotion, not merely to the acquisition of knowledge, but chiefly to the advancement of knowledge for its own sake, is the peculiar possession of universities.

This does not mean that teaching is not also an important university function; but it means rather that teaching is to be made most effective in an atmosphere of research. The university investigator not only lives on what may be called the "firing line" of his subject, but he is training group after group of recruits to continue the conquest of the unknown. To extend the boundaries of human knowledge, and to multiply oneself in genera-

[1] Response to the toast "Our Universities" given at the annual banquet of the American Philosophical Society, April 15, 1916.

tions of students, is the high privilege of the university investigator.

It is a point of view that seems to separate him from the ordinary interests of men, but to separate oneself from the vast majority of one's fellows in denying the ordinary ambition for place or for wealth; to devote oneself to the research for truth, with no expectation of recognition, except from a select coterie of colleagues; to spend one's energy upon investigations that will neither interest nor benefit mankind, except as they gradually enlarge the boundaries of knowledge, is a spirit distinctly fostered by the university.

In these days the demand that investigators shall be of practical service is swelling into a universal chorus. This demand fails to recognize the fact that to meet immediate need is relatively a superficial problem; and that the more fundamental the problem, the wider are its possible applications. For thousands of years the superficial problems of plant-breeding were attacked, and agriculture became a reasonably successful practise; but when such fundamental problems as evolution and heredity came to be attacked, an incidental result was a revolution of practical plant-breeding.

The study of anything that holds no relation to the needs or convenience of mankind is peculiarly difficult of comprehension by the American public, and the general sentiment is either opposed or at most indifferent to it. This feeling is emphasized by the development and rapid growth of technological schools, in connection with which there has developed one of our most serious problems. It can hardly be denied that the rigidity of the old American college in denying this form of special training its proper place, and thus controlling its prerequisites, forced the establishment of schools of applied science with no educational basis. And now the universities are confronted with the problem of incorporating this form of training into their organization without weakening it.

There must be the pursuit of science for its own sake, for it is the life-blood of a university; and there must be the application of science, for this is the genius of the age. Can these two exist together in the same university organization, and with mutual profit? The grave danger is that the essential function of a university may be given less opportunity to develop than certain subsidiary functions. The time has come, however, when the barrier between pure and applied science is more artificial than real, when each is essential to the best development of the other. Applied science is becoming so grounded in pure science that the former is only one of the natural expressions of the latter; and applied science has passed through its empirical stage and can advance now only as it cultivates pure science. The problem, therefore, is not so much one of grafting, as of cross-fertilization, that the strength of both may be combined in a single organization.

Perhaps it is fitting in this connection to sound a note of warning. In these days of efficiency, when university faculties are being checked up on the basis of the number of students and the number of hours spent with them, there is grave danger that efficiency of this type may be secured at the expense of investigation; in other words, that the teaching function of the university may be exalted above its research function. This would be disastrous, but it is certainly true that the atmosphere of business efficiency is not the atmosphere in which investigation can flourish, for research knows no limits of time and strength and numbers of students.

The normal atmosphere of a university is investigation; and the method of instruction is through companionship in investigation. The appropriation of previous knowledge is no longer the chief purpose, but is entirely subsidiary to the discovery of additions to knowledge; and the ability to stimulate students to investigate becomes the chief problem of teaching. This truth is so fundamental that without it there can be no universities distinct from colleges, no matter how prolonged the instruction may be. The distinction is one of controlling purpose; in the one case it is chiefly acquisition; in the other case it is chiefly the development of initiative. In other words, we are equipped to teach through in-

vestigation, at least in an atmosphere of investigation, and anything that vitiates this atmosphere impairs our teaching function as well.

The universities must see to it, therefore, that there is developed a renewed appreciation of the place of research in the university, and an increasing determination to permit no other function to diminish its opportunity, and to allow no method of administration to depress its spirit.

John M. Coulter
University of Chicago

THE SAN DIEGO MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Several societies have determined to participate in the San Diego meeting of the Pacific Division of the American Association occurring between the dates, August 9 and 12, 1916. These societies will welcome the presentation of worthy papers from any of their members or from any members of the Pacific Division. Titles of papers to be presented, together with brief abstracts of their contents, should be forwarded to the secretary of the society before which the paper is to be offered as soon as possible and well in advance of the date of the meeting. The societies which will meet at San Diego are:

The Astronomical Society of the Pacific, Secretary, D. S. Richardson, 2541 Hilgard Avenue, Berkeley, California; the Cordilleran Section, Geological Society of America, Secretary, J. A. Taff, 781 Flood Bldg., San Francisco, California; the Western Society of Naturalists, Secretary, E. L. Michael, La Jolla, California, meeting in conjunction with the San Diego Natural History Society and the Pacific Slope Branch of the American Phytopathological Society; the Pacific Slope Branch, American Association of Economic Entomologists, Secretary E. O. Essig, University of California, Berkeley, and the Ecological Society of America, Secretary, Forrest Shreve, Desert Botanical Laboratory, Tucson, Arizona.

The opening of the San Diego meeting will be preceded on Wednesday, August 9, by exercises for the dedication of the recently completed museum building and concrete pier at the Scripps Institution for Biological Research at La Jolla near San Diego. At the opening session of the meeting of the Pacific Division will be given the annual address of the President of the Division, Dr. W. W. Campbell, director of the Lick Observatory, Mount Hamilton, California, upon the subject, "What we know about Comets." This address will be followed by a reception to visiting scientists. On Thursday and Friday evenings, August 10 and 11, two other general public addresses will be given by Dr. Barton W. Evermann, director of the museum, California Academy of Sciences, San Francisco, upon the subject, "Modern Natural History Museums and their Relation to Public Education," and Dr. F. F. Wesbrook, president of the University of British Columbia, upon a subject to be announced later.

The San Diego committee in charge of the local preparations for this meeting is as follows:

Dr. Fred Baker, Point Loma, chairman; W. C. Crandall, business manager of the Scripps Institution for Biological Research, La Jolla; Stanley Hale, San Diego County Chamber of Commerce, San Diego; E. L. Hardy, president of the California State Normal School, San Diego; Dr. E. L. Hewitt, director of the School of American Archeology, Santa Fe, New Mexico; Duncan MacKinnon, superintendent of schools, San Diego, and Dr. Wm. E. Ritter, director of the Scripps Institution for Biological Research, La Jolla.

In addition to the three general meetings of the Division and the meetings of participating societies on Thursday and Friday, a number of excursions to points of special scientific interest in the vicinity of San Diego are being planned. The committee in charge of these excursions consists of the following members of the staff of the Scripps Institution for Biological Research, La Jolla: Dr. F. B. Sumner, chairman, Dr. George F. McEwen and E. L. Michael.

The usual excursion rates of a fare and a third have been granted by the railroads from points in the states of Arizona, California, Oregon, Washington, Idaho, Nevada and Utah, and from British Columbia. In taking advantage of these rates, members are cautioned

to secure special certificates when purchasing their tickets to San Diego, paying one full fare from the point of departure to San Diego. These certificates when signed by the secretary of the Pacific Division and by a railway representative at San Diego will entitle the holder to a return ticket upon the payment of one third of the regular fare, plus the validation fee of fifty cents.

Tickets will be on sale in California, Arizona, Utah and Nevada from August 7 to 15, inclusive, and in Oregon, Washington, Idaho and British Columbia from August 2 to 11, inclusive. Tickets will be honored for return from August 9 to 17, inclusive.

Visitors attending the San Diego meeting from the north may include a trip to the Yosemite Valley on either portion of the trip by choosing a route over the San Joaquin Valley lines of the Southern Pacific or Santa Fe Railways. Transfer from the main lines is made at Merced and the additional cost of the trip from Merced to the Yosemite Valley, including automobile transportation from the end of the railroad at El Portal into the Valley, is $18.50. If the trip is extended to the Wawona and Mariposa Grove of Big Trees, the charge is $33.50, and if by way of Glacier Point, $37.50.

One fare rates to San Diego have been quoted as follows:

Los Angeles	$3.75
Tucson	23.20
Salt Lake City, via San Francisco	43.85
via Salt Lake Route	34.35
Reno	22.20
San Francisco	16.80
Portland	34.70
Seattle	40.30
Vancouver	44.55
Moscow	45.80

Special exposition rates have been made from points in Utah to San Diego, direct or by way of San Francisco, over lines of the San Pedro, Los Angeles and Salt Lake Railway Salt Lake Route. Full information concerning these rates may be secured from local agents.

Steamship rates have been quoted as follows:

By the Pacific Coast Steamship Company, round trip from San Francisco to San Diego and return, good for thirty days, $17.00, including berth and meals; from Seattle, Tacoma, Everett and Vancouver to San Diego and return, round trip good for thirty days, $53.00, including berth and meals.

By the Pacific Navigation Company, from San Francisco to San Diego, round trip tickets on sale from June 1 to September 30, good for ninety days, return date not later than October 31, $12.50, berth and meals extra.

By the Great Northern Pacific Steamship Company, from Portland to San Francisco by steamer and from San Francisco to San Diego by rail, one way fare, $31.70; return ticket in conjunction with railway rate, authorized on receipt certificate plan, $14.70.

SCIENTIFIC NOTES AND NEWS

THE fourteenth annual session of the South African Association for the Advancement of Science will be held at Maritzburg on July 3 to 8, inclusive, under the presidency of Professor L. Crawford, professor of mathematics, South African College, Cape Town.

ON May 20 the former students and friends of Professor Gage gave him a complimentary dinner on his sixty-fifth birthday. The dinner was attended by more than 100, including several of his former students from out of the city. A large number of letters and telegrams of congratulation were received from those unable to attend. At this dinner a fund was presented to the university for the purpose of establishing at Cornell University a Simon Henry Gage Fellowship in Animal Biology in honor of Professor Gage.

A COMPLIMENTARY dinner was given to Dr. S. J. Meltzer, at the Chemists Club on May 15, by a group of friends and associates. The speakers at the occasion were, Drs. Haven Emerson, W. J. Gies, H. C. Jackson, Frederic S. Lee, Jacques Loeb, Graham Lusk, L. B. Mendel, T. H. Morgan and E. B. Wilson.

A COMPLIMENTARY dinner was extended to Dr. Daniel W. Hering, professor of physics and dean of the graduate school of New York University by his colleagues of the faculties of the college of pure arts and sciences, the school of applied science and the graduate school on May 29 at the Hotel Manhattan. Dean Hering retires in June.

Professor Richard Elwood Dodge, after twenty years' service as teacher of geography in Teachers College, Columbia University, has resigned his professorship, to devote himself uninterruptedly to those aspects of geography that interest him most, applied geography in the field of rural and especially agricultural education.

The department of anthropology in the American Museum of Natural History, New York City, has strengthened its division of physical anthropology by two appointments: Professor J. H. McGregor, of Columbia University, research associate, and Mr. Louis R. Sullivan, of Brown University, research assistant. In addition, Dr. Bruno Oetteking will spend another year at the museum preparing a report on the physical anthropology of the Jesup expedition.

The Franklin Institute has awarded its Elliott Cresson Gold Medal to Dr. Robert Gans, of Pankow, near Berlin, Germany, for permutit, a sodium-alumino-silicate used for softening water.

Professor Henri Lecomte, Professor Edmond Perrier and Professor Pier' Andrea Saccardo have been elected foreign members of the Linnean Society.

Upon request of the Bureau of Mines, a committee of the American Chemical Society has been appointed as an advisory committee to the Bureau of Mines on chemical problems in connection with its investigations. The committee consists of Drs. C. H. Herty, L. H. Baekeland and W. R. Whitney.

The Standing Committee on Metallurgy appointed by the British Advisory Council for Scientific and Industrial Research consists of the following members: Professor J. O. Arnold, Mr. Arthur Balfour, Professor H. C. H. Carpenter, Dr. C. H. Desch, Sir Robert Hadfield, Mr. F. W. Harbord, Mr. J. Rossiter Hoyle, Professor Huntington, Mr. W. Murray Morrison, Sir Gerard Muntz, Bt., Mr. G. Ritchie, Dr. J. E. Stead, Mr. H. L. Sulman and Mr. F. Tomlinson.

Professor Ralph H. Curtiss has been granted a leave of absence by the board of regents of the University of Michigan for two or three years. He will go to Argentina to inaugurate stellar spectroscopic work at the observatory of the University of LaPlata. Leave of absence was also granted to Mr. H. J. Colliau, who will accompany Professor Curtiss and assist in installing the spectrograph and other apparatus. Mr. Bernhard H. Dawson, who has been studying at the University of Michigan, will leave some time in July to resume his position as astronomer in the observatory of LaPlata.

The first representatives of the Maury expedition to the Tertiaries of San Domingo, A. Olsson and K. P. Schmidt, left the paleontological laboratory at Cornell University on the twenty-ninth of April. Dr. Carlotta J. Maury, holder of the Sarah-Berliner fellowship in paleontology this year and lecturer in the university proceeded to the same field on May 26.

By a recent gift of $2,500 from an unnamed donor, the department of geography at the University of Chicago is enabled to undertake a scientific study in Asia, and Assistant Professor Wellington D. Jones will sail from Vancouver for Yokohama on June 15, to be gone for six months. His work will cover a wide range, including Japan, Korea, Manchuria, and Northern and Central China. If political conditions in China permit, Professor Jones hopes to work back into Shansi and Shensi, and into the Red Basin of the upper Yangtze. His chief interest is in the relation between man and the physical environment of the region in which he lives.

Dr. R. Tait McKenzie, head of the department of physical education at the University of Pennsylvania, who has been in the British service during the past year, will return and resume his duties at the university next September on the conclusion of his year's contract in England.

Dr. Howard A. Kelly has been granted leave of absence from the Johns Hopkins Hospital for a year, in order to devote all his time to further research work in radium. Dr. Thomas S. Cullen will be in charge of Dr. Kelly's classes in gynecology.

W. A. LINTNER, assistant professor of agronomy at Delaware College and assistant agronomist of the Delaware Agricultural Experiment Station, has resigned to go into commercial work.

PROFESSOR W. P. MASON, of the Rensselaer Polytechnic Institute, delivered the address at the annual meeting of the Sigma Xi Society, Union College, on May 23. His subject was "Water from the Ground."

AT the ninety-ninth convocation of the University of Chicago, held on June 6, in connection with the celebration of the quarter-centennial of the university, the address on behalf of the faculties was made by Dr. Thomas Chrowder Chamberlin, head of the department of geology and paleontology.

THE Bakerian Lecture of the Royal Society was delivered on May 25 by Professor C. G. Barkla, on "X-rays and the Theory of Radiation."

A FUND of about $2,500, the income from which will provide a prize to be known as the Charles Lee Crandall prize, has been presented to Cornell University by the Cornell Society of Civil Engineers on behalf of the alumni of the college. The prize will be awarded in accordance with terms to be fixed by Professor Crandall.

CHARLES SOOYSMITH, known throughout the United States as a civil engineer, especially for his work on the pneumatic caisson and freezing processes in excavations, died at his home in New York, on May 1, at the age of sixty years.

MISS CORA HUIDEKOPER CLARKE, of Boston, a fellow of the American Association for the Advancement of Science, who had published work on insect-cells and on the mosses of New England, has died, at the age of sixty-five years.

WE learn from *Nature* that a general meeting of the British Chemical Society was held at Burlington House on May 11, to consider the question of the removal of the names of nine alien enemies from the list of honorary and foreign members of the society. No decision was reached and the meeting was adjourned.

THERE was installed in the department of geology of the University of Oklahoma the Gamma chapter of the Sigma Gamma Epsilon. The Beta chapter of this fraternity is in the school of mines of the University of Pittsburgh and the Alpha chapter in the departments of geology and mining in the University of Kansas. Sigma Gamma Epsilon is a national college fraternity devoted to geology, mining and metallurgy and holds a place parallel to that of Alpha Chi Sigma, the national college fraternity devoted to chemistry. The fraternity has just completed the first year of its existence; but with its third chapter installed and petitions from other institutions before its national council bespeak for it a promising future. Communications intended for its national officers should be addressed to either H. E. Crum, Bartlesville, Oklahoma, or W. H. Twenhofel, Lawrence, Kansas.

THE annual New England intercollegiate excursion will be taken on October 14 in the Blue Hills district of eastern Massachusetts. It will be under the direction of Professors W. O. Crosby and C. H. Warren.

GOVERNOR WHITMAN, of New York, on May 22, signed the appropriation bill passed by the legislature, which included an item of $65,000 for the purchase of land and the erection of a laboratory building in the city of Albany for the State Department of Health. The site chosen closely adjoins the Albany Hospital and the new Albany Medical School. The laboratory work of the Health Department is at present carried on with great difficulty in an old stable which has several times been condemned as unsanitary.

WE learn from the *Journal* of the American Medical Association that Dr. Steele, M.P., North Oxford, Ont., has introduced a resolution in the Canadian House of Commons expressing the greater need at the present time for a national department of health than at any previous time in the history of the Dominion. He pointed out that while all the provincial governments maintained well-organized health boards, the Dominion had the

control of many matters relating to the health of the people distributed over eight or ten departments of the government. Practically every European nation, with one or two small exceptions, has organized national health departments, but Canada lags behind. He spoke of the progress made in the United States toward a department of health; also in Japan. There was urgent need for such a department in Canada, as at the close of the war there would in all probability be a greater influx of immigrants than ever before in the history of the country. He believed that 40 per cent. of the babies dying in Canada every year could be saved. It was promised by the government that the matter should receive due consideration. The Canadian Medical Association first began to urge a federal department of health on the Canadian government in 1901.

The National Museum has recently received a one-kilogram fragment of a stony meteorite that was brought up in a seine by a fisherman, in Lake Okechobee, Florida. The stone is of interest on account of the unusual conditions under which it was found, and being also the first meteorite thus far reported from that state.

At the meeting of the Buteshire Natural History Society held on February 8, in the society's library at the Bute Museum and Laboratory, Dr. Marshall, president, in the chair, the curator, Mr. L. P. W. Renouf, explained at some length the aims and objects of the laboratory and museum under it new régime. Briefly these are to get together a complete collection of the fauna and flora of Bute and its more or less immediate waters, to supplement the actual collection with a card index of occurrences over an extended period so as to have a complete local history of the species, and to provide accommodation for any one desirous of working at any of the problems of natural history. Emphasis was laid on the exceptional advantages offered by Bute for such an undertaking, its size, position and industries combining to make it an ideal site for the work. The laboratory offers all the necessary facilities for research work and possesses equipment for the carrying on of both marine and fresh-water investigations, and the museum already contains the nucleus of a very fine collection. Intending workers should apply to Mr. Renouf, who will be glad to supply any particulars.

The fourth season of the Indiana University summer school of field geology will begin on June 15, 1916, under the direction of Dr. J. W. Beede. The party will continue the study of the Clay City, Indiana, quadrangle. This is regular work in geologic surveying, including the mapping of the stratigraphic and economic geology, the study of the paleontology, physiography and geography of the quadrangle. This field work furnishes the data for papers and theses which are published by the students. In as much as the results are of educational and economic value to the state, the expenses of graduate students having sufficient preparation are met. The party is housed in tents.

Mrs. Isaac L. Rice has purchased from Cornell University fourteen acres of land at Irvington-on-Hudson as a site for a $1,000,000 hospital for convalescents to be erected as a memorial to her husband, the inventor and philanthropist. The buildings, it is said, will cost about $250,000. Mr. Rice, who was president of the Holland Torpedo Company and of the Electric Boat Company, died in November last.

The mining of copper began in Alaska in 1901 and the total output of the metal to the close of 1915 is 219,913,375 pounds, valued at $34,919,581. Of this amount, according to the statistics recently completed by Alfred H. Brooks, of the United States Geological Survey, 86,509,312 pounds, valued at $15,139,129, was produced in 1915. This is more than four times the output of 1914, and by far the greatest in the history of the Alaska industry. Thirteen Alaska copper mines were operated in 1915 compared with seven in 1913. A total of 369,600 tons of ore was mined in 1915 which, in addition to the copper, carried gold to the value of $153,121 and $455,204 worth of silver.

THE department of geology of Northwestern University will conduct a geological field course in the Lake Superior Region during August. It will be devoted largely to a study of the Pre-Cambrian rocks with some attention to the Pleistocene history. It is expected that a day or two will be spent at the head of Lake Superior where both the intrusive and the extrusive phases of the Keweenawan may be seen, as well as ancient lake beaches, great ore docks, etc.; one day on the Mesabi iron range; and one day on the productive portion of the Vermilion iron range. After this the class will live in camp and will travel by canoe through some of the lakes near the Minnesota-Ontario boundary where there are extensive exposures of various types of metamorphic and igneous rocks. These rocks will be studied and small areas will be mapped in detail.

UNIVERSITY AND EDUCATIONAL NEWS

AT the annual spring meeting of the General Education Board $789,980 was appropriated for institutions and projects to which the organization contributes. The largest appropriation was for the medical department of Washington University at St. Louis, which received $250,000. This makes $1,000,000 given by the board to this institution toward a total of $1,500,000 for the purpose of placing the teaching of medicine, surgery and pediatrics on a full-time basis. Other appropriations were: Coker College, Hartsville, S. C., $50,000; Colby College, Waterville, Me., $125,000; Rockford College, Rockford, Ill., $75,000; further prosecution of educational researches, $50,000; Spellman Seminary, Atlanta, Ga., $20,000; Hampton Institute, $25,000; Tuskegee Institute, $25,000; Morehouse College, Atlanta, $5,000; Fisk University, Nashville, $5,000; Mayesville Industrial School, Mayesville, S. C., $1,000; equipment of normal schools for negroes in North Carolina, $4,050; equipment of county training schools for negroes, $10,000; support of professors of secondary education, $34,130; state agents for white rural schools, $40,800; state agents for negro schools, $34,500; educational research in New Hampshire, $5,500; farm demonstration work in Maine and New Hampshire, $8,500.

PLANS for the union of the Jefferson Medical College with the University of Pennsylvania and the Medico-Chirurgical College and hospital have been completed. The Medico-Chirurgical College is to become a post-graduate school, to be known as the Medico-Chirurgical College and Hospital-Graduate School in Medicine of the University of Pennsylvania. The Jefferson Medical College will be connected with the university, but will maintain its identity.

THE University of Sheffield has received $160,000 by the will of Sir Edgar Allen, $25,000 for the applied science department, and the balance to be devoted to providing scholarships, half of them to be reserved for the sons of working men.

FRANK ADAMS has been appointed professor of irrigation investigations in the University of California. He will continue also his work in the irrigation and drainage investigations of the United States Department of Agriculture.

DR. ARTHUR HARMOUNT GRAVES, formerly assistant professor of botany in the Sheffield Scientific School of Yale University and instructor in forest botany in the Yale Forest School, has been appointed associate professor of biology in the new Connecticut College for Women, at New London, Connecticut. Dr. Graves will have charge of the instruction in botany.

DISCUSSION AND CORRESPONDENCE

THE SECOND YEAR OF COLLEGE CHEMISTRY

THE selection of courses immediately following general chemistry is a matter of great importance. The traditional method—old-fashioned qualitative analysis and then quantitative analysis—is being questioned.

It has long been recognized that qualitative analysis is not an end in itself—that it is of value rather in teaching advanced inorganic chemistry in a systematic way. In the last few years certain men have interpreted quali-

tative analysis by the principles of physical chemistry and thus made it an introduction to the latter subject. Others have, even more recently, demanded a quantitative interpretation of results and thus made the course an introduction to quantitative analysis.

There is no longer room in a modern course in chemistry for any extended treatment of qualitative analysis without great use of the fundamental principles of physical chemistry. For that matter, these principles are taught in general chemistry, but they are not thoroughly digested in the first year, probably because of a first-year tendency to bolt rather than to masticate such food. After the somewhat hurried meals on countless viands in the general subject the student is ready to settle down in the second year to a more thorough assimilation. Yet if at this stage he is given an endless round of unknowns in the old qualitative system he soon learns all the manipulation required, gains all there is for him from the classification, and then spends his time for months learning one new reaction after another in true encyclopedic fashion without any further great advance in general principles. He learns something more, of course, and may even enjoy the game indefinitely; but his time, after a limited amount of such work, could be spent to better advantage. A full year of this repetition work has been given in some colleges—crowding out more valuable training.

The attempt to make qualitative analysis approximately quantitative has the great defect of "delaying the game." The same discipline can be given later much more rapidly and effectively in genuine quantitative analysis. There are not enough new principles learned by this slow method to justify the very considerable time required. Furthermore, the points of teaching value are repeated *ad infinitum* without great additional gain.

In a word, qualitative analysis has had too large a place in the chemical curriculum. Far better to give the student a limited amount of this and advance him more rapidly by other courses. He will then be able to add to his knowledge of qualitative methods as required, independently of his teacher.

There are now a few excellent texts treating qualitative analysis from the viewpoint of physical chemistry, but they could be improved by the addition of laboratory drill, using accurate demonstrations of some of those fundamental principles on which students look with awe—or doubt—in the first year. True, such experiments are not qualitative at all, but it is to be hoped the instructor would rather teach advanced chemistry effectively under any name than secure the barren triumph of remaining within the narrow limits of qualitative analysis. Call it analytical, advanced inorganic—the name matters little.

Many "laws" were gulped down in general chemistry with an antiferment of skepticism to interfere with their proper digestion. To require these students in their second year actually to duplicate the historical experiments which gave occasion for those "laws" is to lay solid foundations and kindle the spark of inspiration.

Professor W. H. Chapin, in our laboratory, has developed such a course and it is well worth the attention of other teachers. Molecular theory, atomic theory, solutions, the electrochemistry of solutions, colloids, equilibrium, oxidation and reduction, complex ions and other topics of like nature are treated somewhat as in the splendid book of Stieglitz. But Professor Chapin goes farther and advocates the use of accurately performed experiments on the heat of neutralization, Boyle's law, combining weights, valence, Faraday's law, colloids, speed of reaction. Oxidation and reduction are illustrated by volumetric relations between standard solutions of oxidizing agents and reducing agents. The determination of molecular weights in two ways, the abnormality of freezing point lowering as an evidence of ionization, and other experiments of this type are found stimulating.

This work is followed by a rather brief treatment of qualitative analysis taught to illustrate the principles of equilibrium, complex ions, amphoteric hydroxides, etc., rather than as an end in itself. It is noteworthy that the previous drill in fundamentals gives the student greater facility in learning the quali-

tative routine. There is also a gain in quantitative discipline because, for example, the drill in combining weights includes the usual quantitative determination of silver as chloride and the volumetric work illustrating oxidation and reduction simplifies much of the quantitative course to follow.

A semester of this course is to be followed by quantitative analysis proper with stress on the illustration of principles.

To give this second-year course profitably the last three months of general chemistry should be devoted—in the laboratory—to the simplest possible system of qualitative analysis taught without much use of physical chemistry. I have used such a system for several years and find that it pays. The gain here is in teaching the student classification, comparison, logic, showing him a focus for the many isolated facts he had accumulated and which had begun to tire him. There is also a certain craft on the part of the teacher using this plan, for there are few first-year students not roused to enthusiasm by qualitative work. Many remain in the department for advanced courses who would otherwise have lost interest. Yet no time is wasted, for such a foundation makes possible the second-year course outlined above. The majority of every class in elementary chemistry do not go on to advanced chemistry. This plan gives them a more rounded training.

Better a genuine system than attempts to popularize the subject by unrelated tests of foods. The student has a right to a proper mental discipline even though he does not always insist upon that right.

HARRY N. HOLMES

OBERLIN COLLEGE

STYLOLITES IN QUARTZITE

TO THE EDITOR OF SCIENCE: Dr. F. L. Ransome describes and figures what he calls "Naturally Etched Quartzite" in his report on the Geology and Ore Deposits of the Breckenridge District, Colo.[1] While conducting a field course in geology from the University of Missouri in this area during the summer of 1915, the writer observed these so-called etched surfaces and interpreted them in the same way as Dr. Ransome had done, until one of the students brought in to camp a piece of the quartzite with a new structure. This was immediately recognized as a fragment of a stylolite. The writer investigated the locality at once, as he had been studying this particular structure in limestone for a number of years and was much interested in such an unusual mode of occurrence.

The locality where the stylolite was found was near where the 10,500-foot contour line crosses the small area of Dakota quartzite to the northeast of Lincoln in French Gulch. This slope is covered with masses of quartzite boulders. The study of a few specimens soon revealed the fact that the so-called etched surfaces were the exposed ends of stylolites, a type of surface the writer was very familiar with from his study of stylolites in limestone.

The very rough pitted surface produced by the stylolitic rods is well shown in Fig. 1 on plate 31 of Dr. Ransome's memoir. The depth of the depressions depends upon the length of the stylolitic columns which are rarely over one and three quarter inches in the quartzite, the majority being less than one inch (between one fourth and five eighths of an inch). When the stylolitic columns are short the pits are shallow and well rounded. Since the plane near the end of the stylolitic zone is a plane of weakness the majority of the fractures of the rock are along these planes, thus accounting for the abundance of the pitted surfaces among the quartzite boulders. The writer collected a series of specimens showing all gradations between stylolites and the so-called etched surfaces. Many specimens were collected which show the depressions still occupied by part of a stylolitic column, the fracture having occurred along the plane near the end of the columns rather than having followed the irregular line of contact of the stylolites. After the fractured surface has been exposed to the weather these ends are loosened and fall out, thus leaving the depressions. In some specimens the stylolites can be

[1] F. L. Ransome, U. S. G. S., P. P. 75, pp. 36–37, and plate 31.

seen on the side, with the ends of the same stylolitic columns forming the etched surfaces. A plane of stylolites may be continuous with one of the pitted surfaces. The sides of the depressions sometimes show the characteristic striations of the stylolitic columns.

So many examples show the absolute relationship and interdependence of the so-called etched surfaces and the stylolites that there can be no doubt that the two features are one and the same thing. Some solvent action has been exerted upon the surfaces because the areas between the depressions are well rounded in many specimens, but the major depressions are the result of the stylolites. Many specimens were found which still retained the usual coating of ferruginous clay.

W. A. Tarr

University of Missouri

THE DEFINITION OF ENERGY

To the Editor of Science: Language is an arrangement of words used to express and to convey ideas—and sometimes to conceal ideas or lack of ideas. More than twenty-one years ago, when compiling my "Mechanical Engineers' Pocket-book," I wanted some language in which to convey to students an engineer's idea of energy, and with Rankine, Weisbach and other books at my side, I finally wrote the following:

> Energy, or stored work, is the capacity for performing work. It is measured by the same unit as work, that is, in foot-pounds. It may be either *potential*, as in the case of water stored in a reservoir, capable of doing work by means of a water-wheel, or *actual*, sometimes called kinetic, which is the energy of a moving body.

In the several revisions my book has undergone since 1895 I have never found any reason to change the wording of this definition. Now I find in Professor Garver's article in Science of April 21, 1916, that this definition "conflicts with facts," leads to "logical absurdities," is "defective and misleading."

Desiring to find, for the next revision of my book, the best possible language, or form of words, in which to convey the idea commonly expressed by the word "energy," that is to get the best definition of the word, I have read Professor Garver's article with great care, and I find the following:

> We are acquainted with matter only as that which may have energy communicated to it from other matter, and which may in its turn convey energy to other matter.
>
> Energy we know only as that which in all natural phenomena is continually passing from one portion of matter to another.
>
> This latter, and later, conception of energy seems, to my mind, a long step in advance over the conception of energy as the "capacity of doing work."

From these statements we may derive the following definitions:

Matter.—That which may convey energy to other matter.

Energy.—That which is continually passing from one portion of matter to another.

Matter.—That which may convey that which to other that which.

Professor Garver also says:

> There is no more necessity for a "definition" of energy than there is for a definition of "matter." Both are known only by their characteristic phenomena; and these characteristics must serve to identify them and to differentiate them from each other.

But there is a necessity for definitions of both of these terms. The users of my book demand them. Every young student demands that a technical term in a text-book be defined in words that are less technical or more elementary than the term itself. For example, I define matter as follows:

> *Matter.*—Any substance or material that can be weighed or measured. It exists in three forms: solid, liquid and gaseous. A definite portion of matter is called a body.

The language used to convey ideas of physical phenomena to students of elementary physics should begin with the simplest and most easily understood words. For example, stone, water, air, solid, liquid, gaseous. The stone, water, air have some qualities in common. They occupy space, can be measured or weighed, and can not be put in motion except

by the application of force. Anything that has these qualities is called "matter," hence the definition of matter. Lift the stone. The lifting requires the application of force. Force, a push or a pull. Resistance, a force which acts opposite to the lifting force, the force of gravity in this case. The stone weighs 10 pounds, it is lifted 5 feet against a resistance of 10 pounds. The operation of lifting or of overcoming the resistance through a distance is called work. Work is defined as the exertion of force or the overcoming of resistance through space, and is measured as the product of the force and the distance. The product of 10 pounds and 5 feet is 50 foot-pounds of work. Let the stone fall. Gravity is now the applied force and there is no opposing resistance (neglecting the slight air-resistance) until the stone reaches the earth. It acquires speed during the fall, the speed increasing at the rate of 32.2 feet per second in each second, and when it has fallen 5 feet it has attained a velocity $V = \sqrt{2gh} = 17.9$ ft. per sec.

Thus the student is led forward from the simple concepts which he already has, say at the age of 12 years, as clear as he will ever have them throughout his life, of solid, liquid, gas, distance, force, time, to the meaning of the general term "matter" and to the compound concepts work and velocity, and he is now prepared to go a step further and meet the words, stored work, energy, potential and kinetic, energy of motion, mechanical energy, and to understand the definition: Energy, or stored work, the capacity for performing work.

This definition is pedagogically sound, scientifically accurate as any definition can be, sanctioned by sixty years or more of usage by the best writers, and expressed in language that is probably as clear and satisfactory as any other that can be invented. It fits easily the energy formula $FS = \frac{1}{2}MV^2$, and when heat energy and electrical energy are studied, the doctrine of conservation of energy.

If there is any "existing confusion in the use of the word energy" it is due to modern writers who have departed from the good old definition. When they return to it the confusion will disappear.

WM. KENT

SCIENTIFIC BOOKS

The Vegetation of a Desert Mountain Range. By FORREST SHREVE. Carnegie Inst. Wash. Pub. 217. Washington, 1915. 8vo. 112 pp., 18 figs., 36 pls., 1 chart.

This book is addressed especially to workers in physiological plant ecology, but it should be valuable, also, to students of physiographic ecology and to those whose interest lies primarily in the floristic aspects of vegetations. Furthermore, all who respond to the undefinable call of deserts and mountains will sense the impulse that leads to pack-saddle and sleeping-bag, if they will but glance at the wonderfully good half-tone illustrations here brought forth. It is a little to be regretted that these plates, at the back of a rather special scientific monograph, may not reach nearly all who might derive much pleasure and profit from them. This is a characteristic of good ecological work, that it interests not only the specialist in out-of-door biology, but also nature-lovers in general and non-ecological scientists.

Perhaps the most striking general feature of the monograph lies in the fact that Shreve's presentation of his very thorough knowledge of this mountain range does not stop with pictures and descriptions, nor does it depend, for its scientific interest, upon general theories as to how the various features considered may be related. He goes much farther, and devotes more than half the book to measurements of climatological conditions and actual correlations between these and plant distribution. Realizing the fundamental importance of climatic features in determining plant activities, students of plant distribution have long wished for this sort of treatment, but only a few have thus far found the opportunities, the patience and the insight, to correlate quantitative climatic measurements with ecological observations. This publication will probably have its greatest value to ecological science in the suggestions that it offers as to quantitative methods of attack upon the vegetation-climate correlation.

The Santa Catalina range lies near Tucson, Arizona, and rises from a basal elevation of about 3,000 feet to a height of 9,150 feet, thus

presenting an altitudinal range of over 6,000 feet. The gently-sloping plains or bajadas about this mountain-mass are clothed with a low, open vegetation, in which the creosote bush (*Covillea tridentata*) plays the leading rôle. Passing from the base to the summit of the range the observer meets with a constantly changing panorama of vegetation. Shreve considers three vegetational types in this series, the *desert*, the *encinal* and the *forest*. The first type is similar to that of the bajadas, becoming modified as one ascends, and is considered as ceasing at an altitude of about 4,000 feet on the north slopes and 4,500 feet on the south ones. Encinal is next encountered, extending on the south slopes to about 6,300 feet and on the north slopes to about 5,800 feet. This type is characterized by a spotted and open stand of evergreen oaks (*Quercus oblongifolia* and *Q. arizonica*) in its lower reaches, and by nearly closed stands of these and other small trees in its upper region. Juniper, manzanita, and such plants as *Dasylirion, Nolina, Yucca* and *Agave* occur in this region, and another oak (*Q. emoryi*) and a scrub pine (*Pinus cembroides*) are common in the upper encinal. The upper encinal grades into the lower forest, the latter dominated by Arizona yellow pine (*Pinus arizonica*), which extends to the summit of the range on south slopes and to an altitude of about 7,500 feet on north slopes. On the north slopes of the highest points and ridges an entirely different type of forest is encountered, the white-fir forest, which is dominated by *Pseudotsuga mucronata, Pinus strobiformis* and *Abies concolor* (white-fir), the latter especially in the upper regions. The fir forest is by far the most mesophytic of all the habitats considered.

As to floristics, the flora of the desert and encinal regions is closely related to that of the Mexican deserts lying to the south, while the relationships of the forest flora are partly with the flora of the Mexican Cordillera and partly with that of the Rocky Mountains. "The Mexican group is more conspicuous in the make-up of the vegetation, while the Rocky Mountain contingent is apparently preponderant in number of species" (page 40).

Shreve's discussion of the climatic features of this mountain range constitutes the most important part of the study. The duration of the frostless season here receives adequate attention, for the first time in work of this kind, and the two rainy and two dry periods that characterize the year in southern Arizona are also thoroughly dealt with. A pair of graphs (Fig. 3) with ordinates representing the winter and the summer precipitation as percentages of the annual, plotted to a geographic base (13 stations, from Los Angeles to Mesilla Park, N. M.), have, roughly, the appearance of the letter X. The downward-slanting line refers to winter, and the other to summer rainfall. Los Angeles has high winter precipitation and practically none in summer, while Mesilla Park has much more rain in summer than in winter. The center of the X, where precipitation is about equally divided between winter and summer, lies between Casa Grande and Tucson. Rain-gauges and cylindrical porous-cup atmometers were operated at various different altitudes, for a number of summers, and the results furnish much more satisfactory information than has hitherto been available, on the relation between precipitation and evaporation, on the one hand, and altitude and vegetational character, on the other. Soil moisture, soil temperature and various other climatic conditions also receive attention, and all of these are correlated with altitude, direction of exposure and the character of the vegetation.

Probably the most definite advance in method to be found in this book is the employment of the ratio of evaporation to soil moisture-content, for the period of the arid fore-summer. This ratio exhibits a very satisfactory correlation with the character of the vegetation at different altitudes and on different exposures. Such a novel and very promising method should attract the attention of plant ecologists generally. "The ratio of evaporation to soil moisture comprises a measurement of all the external factors which affect the water relations of plants, except the influence of radiant energy on transpiration and the possible effects of soil temperature on this function" (page 93). For a wealth of in-

teresting and important details regarding these and many other topics, the book itself must be consulted.

Ecologists will find in this monograph many new expressions and many new points of view, of most of which those will approve who have come to think of the plant as a complex of physiological processes, rather than as an intricate object to be described and depicted. The newness of this sort of thinking and the complexity of the relations involved have made necessary the employment of a number of new expressions, which may require modification later, but the author is to be congratulated on his general avoidance of words not readily understood by the average intelligence; especially has he avoided that tendency toward ultra-technical, Greek, classificational terms which so hindered real progress during the earlier years of ecological philosophy. He is also to be congratulated on the unusual clearness with which he approaches the relation of conditional control—the relation of cause and effect, in the common sense. Effects are not here confused with causes and plants are not endowed with judgment.

To find fault is as difficult in this case as it always is distasteful, but if fault must be found let it be with reference to a few poorly chosen words, such as vegetistic (for *vegetational*) and habital (for *with regard to habitat*). The latter seems to the reviewer to be actually ambiguous.

B. E. LIVINGSTON

Laboratory Manual in General Microbiology. By WARD GILTNER. John Wiley & Sons. Pp. 418. $2.50.

It is fitting that a laboratory manual in microbiology should come from the laboratories of Michigan Agricultural College following the appearance from the same place of Marshall's "Microbiology." Like the latter book, this manual of Giltner's covers the whole subject included under the term microbiology, so far as to include the study of bacteria, yeasts and molds. The laboratory methods which are here given have been the result of ten years' accumulation of data in the laboratory at Michigan and have therefore the merit of being thoroughly tested. As a compendium of laboratory methods and as a book of reference the book is very valuable, for there is hardly any phase of the rapidly growing study of these three groups of organisms that is not touched upon. It would hardly be possible to use it as a laboratory course, since it goes over an extent of ground which would be practically impossible to cover in any ordinary course. Indeed, it would be of doubtful wisdom to attempt to have any class of students complete such an extensive series of preliminary laboratory exercises as a preparation for the real work of a bacteriologist.

In attempting to cover the whole of the ground of such an extensive study it is inevitable that some topics should be more satisfactorily treated than others. The whole manual shows evidence that it has been developed in an atmosphere of agricultural rather than medical bacteriology. While serum therapy and pathologic bacteriology are treated the treatment assigned to this phase of the subject is less satisfactory than the rest of the manual. An allotment of 34 pages out of 418 to the whole subject of serums and pathogenic bacteriology is either too much or too little; too much if the book is designed for agricultural and general students only, and too little if aimed at medical students.

Naturally slight omissions are found here and there which are open to criticism. To recommend in making culture media the use of Witte's peptone *only*, at this time when Witte's is not to be obtained and when American peptones are proving perfectly satisfactory, is surely open to criticism. To omit absolutely any reference to the preparation and use of Endo medium is hardly defensible, considering the extended and growing use of this medium, and to describe the Gram method of staining without even a reference to the need of counter stain after decolorizing can hardly be excused. But slips of this kind can not be avoided in a book with such a wide scope as this, and the manual is surely to be commended as one of great value in any bacteriological laboratory.

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SPECIAL ARTICLES

A NEW FUNDAMENTAL EQUATION IN OPTICS

ALL the elementary text-books in physics are still using an equation for the conjugate foci of spherical lenses which is too inaccurate for the calculation of microscope objectives, applying with approximate accuracy only to very thin lenses. The same equation is all that is given in the more advanced treatises except those securing a closer approximation by the methods of higher mathematics.

It is possible, however, to develop a simple and rigorously accurate equation by geometry applicable to lenses of any thickness by the simple expedient of measuring the focal distances from the center of curvature of the lens instead of measuring it from the surface as has hitherto been the practise.

The equation is

$$\frac{n}{f}+\frac{n'}{f'}=\frac{n-n'}{r}\cdot\frac{\cos a}{\cos b},$$

in which n and n' are the indices of refraction, f and f' the focal distances of conjugate foci, r the radius of the lens, a the focal angle and b the radial angle. The meaning of these terms will be further explained below.

In the figure EQC' represents the paths of a ray of light refracted at the point Q on the surface of a lens whose radius is OQ.

OF and OF' are drawn parallel with QC' and OE respectively and in the triangle OQF

$$\frac{OF}{QF}=\frac{n}{n'}$$

since they are the sides opposite the angles OQF ($=180°$—angle of incidence) and QOF ($=OQF'$ the angle of refraction).

DD' is drawn through O, making $QD=QD'$, and the angle QOD is the one designated above as the radial angle. QP is perpendicular to DD' and

$$\cos b=\frac{OP}{r}.$$

Since OFD is similar to $OF'D'$ and $QF=OF'$,

$$\frac{OD}{OD'}=\frac{n}{n'},\quad OP=\frac{OD-OD'}{2}=\frac{OD}{2}\left(1-\frac{n'}{n}\right)$$

and

$$\cos b=\frac{OD}{2}\,\frac{n-n'}{rn}$$

or

$$OD=2\cos b\,\frac{rn}{n-n'}.$$

EE' and CC' are drawn through O, making equal angles with DD'. EOD is the angle designated above as the focal angle for the focus E. GH is drawn perpendicular to DD' and lines are drawn from G and H parallel to EQ. Since these three parallel lines are equidistant along GH, $GC=CJ$. The triangles OJH and OCE are similar and

$$\frac{OC}{OE}=\frac{OC-CG}{OC+CG}=\frac{2OC}{OC+CG}-1.$$

Dividing by OC and substituting OG for $OC+CG$ gives

$$\frac{1}{OE}=\frac{2}{OG}-\frac{1}{OC}.$$

The

$$\cos a=\frac{OD}{OG(=OH)}$$

and

$$\frac{1}{OE}+\frac{1}{OC}=2\frac{\cos a}{OD}.$$

Substituting the value of OD found in the last paragraph gives

$$\frac{1}{OE}+\frac{1}{OC}=\frac{n-n'}{rn}\cdot\frac{\cos a}{\cos b}.$$

From similar triangles OCD and $OE'D'$ we have

$$\frac{OC}{OE'}=\frac{n}{n'}$$

or

$$\frac{1}{OC}=\frac{n'}{nOE'}$$

which substituted in the above equation and multiplying by n gives the form of equation desired,

$$\frac{n}{OE}+\frac{n'}{OE'}=\frac{n-n'}{r}\cdot\frac{\cos a}{\cos b},$$

and it only remains to be shown that E and E' are conjugate foci. If the triangle EQE' is rotated upon EE' as an axis, at all points on the circle described by the point Q on the surface of the lens the light radiating from one

focus will be refracted towards the other and the two points E and E' are therefore conjugate foci, and f and f' may be substituted for OE and OE'.

A very similar solution which need not be given here can be obtained for the cases where one focus lies between Q and F or F' and the other on QE or QE' produced and which result in virtual instead of real images.

This equation applies to the refraction at one lens surface. For simple lenses or for lens systems two or more equations, according to the number of refractions, must be combined.

When the cone of light is narrow and does not diverge far from the optical axis the last factor $\cos a/\cos b$ becomes practically 1. This produces the simplest form of the equation. It can be used in calculating the foci of thick lenses in case the aberrations are neglected.

For the study of aberration the angles a and b can be calculated by solving the two triangles EDO and QDO in which EO and QO remain constant and the other sides vary according to the refractive index of the color of the ray of light investigated in the study of the chromatic aberration, or according to the position of Q when studying spherical aberration.

The usual equation found in the books can not be employed for either of the foregoing calculations when more than approximate results are required.

C. W. WOODWORTH

ANTHROPOLOGY AT THE WASHINGTON MEETING

II

A New Type of Ruin Recently Excavated in the Mesa Verde National Park, Colorado: J. WALTER FEWKES.

An account of the excavation and repair of a new type of ruin on the point of a mesa opposite Cliff Palace, conducted under the auspices of the Interior Department and the Bureau of American Ethnology. Before the work was begun, the existence of a large building was indicated by a large mound, the surface of which was strewn with artificially fashioned stones, partly covered with soil, with a few feet of wall showing at one point. On top of the mound, at a place found later to indicate the highest wall, grew a large cedar tree, a cross-section of which revealed 360 annual rings. The building excavated is D-shaped, measuring 122 feet on the straight side and 64 feet broad. The standing walls now contain 120,000 cubic feet. The facing of the walls is artificially pecked with stone implements, and in many instances rubbed smooth. Many stones set in the walls or found in the débris bear incised ornamentation, the beginning of mural embellishment. The masonry is not only among the best in any prehistoric building north of Mexico, but the building itself is the most mysterious yet brought to light in our southwest.

There are evidences that it was neither completed nor inhabited, and evidently it was not intended for habitation. Its ground-plan exhibits a unity in design and a strict adherence to that plan throughout the construction of the building. It is believed to have been constructed by the neighboring cliff-dwellers; it is prehistoric and regarded as more modern than Cliff Palace. A fossil leaf of a palm in relief on the upper surface of the cornerstone at the western end of the building is believed to be a sun symbol, and the walls about it a solar shrine. The building is regarded as a sun temple of the neighboring cliff-dwellers, and is the first of its type yet excavated in the Mesa Verde National Park.

The Passing of the Indian: JAMES MOONEY.

The subject of the aboriginal population of America, and more particularly of the United States, at the first coming of the white man, has been a matter of much speculation, but of very little detailed investigation. There has been about as much error and loose statement on one side as on the other, some theorists claiming for the pre-Columbian period a dense population for which there is no evidence in fact; while others, largely those interested in various civilizing schemes, maintain that the Indian has held his own or is even actually increasing. The claim for a dense earlier population is based chiefly on ignorance of Indian living habit and the error of assuming as contemporaneous in occupancy settlement remains belonging to widely separated periods. The argument for stability or increase of the Indian population rests in part on the error of beginning the calculation with the beginning of federal relations with the tribes, ignoring the centuries of colonization and disturbance which preceded that period, and is also colored to some extent by a desire to draw good results from philanthropic and civilizing efforts.

Another source of confusion in this direction is in the improper designation as "Indian" for administrative purposes, of any individual who can establish even the most remote and diluted Indian ancestry. Thus we have upon the official rolls, and thereby legally entitled to full Indian rights, thousands of persons whose pedigrees show one-thirty-second, one-sixty-fourth, or even less of Indian blood. We need an official, or at least an ethnologic, definition of an Indian, based on the actual proportion of Indian blood. In a detailed study of past and present Indian population of the United States and northern territories, undertaken for the Bureau of American Ethnology, Mr. Mooney arrives at the conclusion that the entire Indian population north of Mexico at the period of earliest white occupancy was approximately 1,140,000, of whom about 860,000 were within the present limits of the United States. The total number has been reduced by about two thirds through disease, famine and war, consequent on the advent of the white man.

Indian Missions in North America: J. F. X. O'CONOR.

Indian missions were established in various states of North America during two hundred and fifty years, from 1613 to 1776, and from that date to 1893. The Indian tribes evangelized during that period were the Abnakis and the Iroquois, the Ottawas, Illinois, Mohawks, the Hurons, Onondagas, the Oneidas, Cayugas, Senecas, Seminoles, the Neuter Nation and the Algonquins, the Kaskaskias, the Natchez tribe, the Yazoos, the Sioux, the Chickasaws and the Nezperces, the Coeur d'Alenes and the Miamis, the Alabamas and the Susquehannas. The Jesuit missionaries visited all these tribes, and among many built churches, mission houses and schools. They lived with the Indians, traveled with them, taught them and strove in every way to bring to them the advantages of Christianity and civilization. They traversed every section of that territory now the United States, from Maine to California, and from the Great Lakes to Florida. These Indian missions were connected with the discovery of the falls and river of Niagara, the discovery of the Mississippi by Marquette, and of Lake George and the salt mines of Syracuse. The records of these earlier missionaries are the most authentic and reliable accounts of the early days of America, and of the lives, customs, occupations, character, in peace and war, of the Indian tribes of North America.

Volumes have been written by the missionaries on the lives and habits of the North American Indian, and the earlier valuable editions have been republished in the monumental series of the "Jesuit Relations" or "Histories of the Indian Missions," by R. Goldthwaites, secretary of the State Historical Society of Wisconsin.

Recent Developments in the Study of Indian Music: FRANCES DENSMORE.

The study of many sciences is dependent, to some extent, on mechanical aid, and the progress of such sciences is measured by the invention or adaptation of such aids. The invention of the phonograph and its recording apparatus marked an epoch in the study of Indian music. It seems probable that the next epoch-marking invention bearing on this study will be that of a device for accurately measuring small intervals of tone.

The musical system in use among civilized peoples contains certain fundamental principles, among them being (*a*) the importance of the keynote, octave, and dominant of the scale, and (*b*) the use of a unit of rhythm. A melodic and rhythmic analysis of six hundred Indian songs (Chippewa and Sioux) shows that the same fundamental principles underlie the structure of a majority of these songs.

The interval of the minor third characterizes the folk-songs of certain European peoples, some of the ancient music of the white race, and the songs of many uncivilized tribes. Analysis of the above-mentioned Indian songs shows that (*a*) the minor third is the interval of most frequent occurrence, and (*b*) the average interval in these songs comprises 3.1 semitones, which is approximately the number of semitones contained in a minor third.

Besides the studies mentioned, tests of tone perception were made among Chippewa and Sioux Indians, with interesting results.

The Beaver Indians: P. E. GODDARD.

The Beaver have hitherto received little or no attention from ethnologists. They live in the Peace River district in northern Alberta, with bands of Cree separating them from the Plains area. Life seems to have been simple in that region, consisting mainly in a severe struggle for food. They depended largely on hunting and trapping, resorting to fishing only in the lack of other food. By means of caches, transportation was avoided as much as possible. Religious life, while simple and devoid of elaborate ceremonies, was emotionally strong. The Beaver fall in with the Slavey and Chipewyan in other particulars

besides language. Their only connections with their linguistic relatives to the south, the Sarsi, seems to have been only recent.

The Growth of the Tsimshian Phratries: C. M. BARBEAU.

In nine unfederated tribes of the Tsimshian proper the phratries were unevenly represented. Evidence shows that the structure and distribution of the four phratries have undergone considerable change in recent times. The phratries, as they now stand, consist of clans either grown out of each other, or introduced from outside and incorporated mostly on account of political circumstances.

The Huron-Wyandot Clans: C. M. BARBEAU.

The exogamic and totemic clans of the Huron-Wyandots are at the basis of their social structure. At least two out of eleven clans are modern and confined to one section of the tribe. The remaining nine clans seem once to have been grouped into two opposite phratries with one odd clan, but the evidence to this effect is slender. The grouping of clans within such phratries must have been largely accidental and of comparatively short duration, since there is barely any record bearing on their existence, and practically no survival.

Herb Medicine Practises of the Northeastern Algonkins: FRANK G. SPECK.

This paper presents lists of plants used in the medicine practises of several eastern Algonkin tribes—the Montagnais, Penobscot and Mohegan. Practically devoid of ceremonial associations in this area, the pseudo-scientific use of herbs by the northeastern tribes is taken as another indication of the primitive character of their culture. Assuming that a simple herbalism unmodified by ritual is more elementary than where subordinated to ceremonial practises, the author brings forth another reason for regarding the northeast as a region where a fundamentally characteristic type of Algonkian culture has survived unmodified by contact with outside and more advanced types. The associations of color, taste, name and the like, are shown to underlie the remedies and their functions in most cases, as appears in the botanical identifications and the analyses of native names.

The Social Significance of the Creek Confederacy: JOHN R. SWANTON.

The Creek confederacy was a result of those social linkings from which, in all parts of the world, nationalities and governments have arisen. Although it originated among peoples related by language and bound together by similar customs and a similar economic life, the constituent parts had themselves been subjected to still earlier unifying tendencies, as is evidenced by their clan systems, and to some extent by their known history. Their gradual consolidation was in accordance with a certain plan having both social and religious aspects, a plan itself probably evolved progressively with the organization. It had a religious seal in the shape of a myth in which a supernatural origin and character were attributed to it.

As with similar complexes elsewhere, some of which have been brought about more rapidly, the Creek organization resulted from a progressive surrendering of cultural, religious and governmental independence by the several parts and approximation toward a typical mean. The relation of the various incorporated tribes, towns and clans to each other and to the entire body, the dual division of towns and of clans, and the method of sharing out the functions of the collective body all bear witness to this evolution and furnish material for comparison with the development of social bodies in other parts of the world.

Notes on the Sign Language of the Plains Indians: HUGH L. SCOTT.

After referring briefly to the development and communication of the languages in general and of the American languages in particular, the author treats of the language of signs employed by divers indigenous tribes which inhabit the region extending from the Mississippi River to the Rocky Mountains and from the Saskatchewan River in British Columbia to the frontiers of Mexico. He also refers briefly to the principal dialects of the American Indians and to the fact that these dialects served as an international vehicle of communication.

With respect to the language of signs, the author demonstrates that it is one of the natural modes of communication and that it obeys the general law of linguistics, with exception of those concerned with phonetics. He traces the history of sign language which in his opinion appeared in the year 1535 of the Christian era and perhaps at a more remote epoch. The author then refers to the opinions and data which the first chroniclers and historians of Spain secured with respect to this language. These Spanish chroniclers and historians make it clear that this language existed in Mexico and was replaced by the spoken language of the Aztecs. The author compares the

signs used by the Indians with those employed by deaf mutes and indicates the origins of the Indian sign language, citing cases related to this class of language which were referred to by Homer in the "Odyssey." In speaking of the signs of the Indians the author treats of pantomime as a means employed in the communication between races of distinct ethnic origin from times of the most remote antiquity. He then refers to the particular sign language of the North American Indians and to the origin and propagation of the signs, as well as to the grammatical rules to which the sign language was subject.

Omaha and Osage Traditions of Separation: Francis La Flesche.

Before the advent of Europeans the Indians had no means other than by oral accounts to transmit their rituals and stories of important events. Narratives, in their transmission, often lost important details of time or place. Accounts of changes that occurred in a tribe became reduced to a few words, as in the story of the separation of the Omaha from the Osage. The Omaha story of the separation came down in two versions: One tells of the attempt to cross the Mississippi in skin boats, of being separated by the rising of a heavy mist; the other, of their efforts to cross the river by means of grapevines spliced together.

On the visits of the Omaha to the Osage and the Quapaw, members of these tribes say to their visitors: "You were a part of us, but you went away in an angry mood and never came back, because in the distribution of sinew you were slighted."

An Osage who recently visited the Omaha gave the detailed story, here recounted, of the separation as told by one who was a recognized authority on the traditions of the Osage. In this story it was shown that at a tribal ceremony two leaders were reproved for violating the hunting usages. Taking offense at this reproof, the two leaders broke away from the tribe with many of the families of the various gentes, and these afterward organized and became known as the Omaha tribe.

Zuñi Conception and Pregnancy Beliefs: Elsie Clews Parsons.

Description of two phallic shrines. To give birth to a girl, men sent out of house during labor. Conception ceremonials. Conception of twins through practises relating to deer. Deer bearing twins. Pregnancy taboos: dyeing wool, firing pottery, viewing a corpse, eating pino nuts, standing at a window, scattering bran on oven floor. Albinism due to parent eating white leaf inside the corn husk; blindness or lameness or malformation to expectant father shooting animals in the eyes, legs, etc. Birth-marks due to father dancing in a ceremonial during the pregnancy; crying from pain in the back, to maltreatment of horses; deafness, to mother stealing before the birth. Curing by inoculation magic.

Some Esoteric Aspects of the League of the Iroquois: J. N. B. Hewitt.

In the esoteric thinking of the early prophetic statesmen of the Iroquois and their co-tribesmen, the League of the Five Tribes as an institution, an organic unity, was conceived as a bi-sexed being or rather person, *i. e.*, an organic whole or totality formed by the union of two human persons of opposite sex. This conception appears in the organic parts of the institution and in the ritual governing the installation of its officers and of those of its constituent organic parts. Owing to the vastly differing viewpoint of the civilized man of to-day from that of the founders of the league, this esoteric meaning with its implications is, perhaps, strange and he may apprehend it only as metaphor, because to him it is only poetic.

To those early prophetic statesmen, life was omnipresent; obtrusively so. For, unconsciously, it had been imputed by their ancestors to all bodies and objects and processes of the complex world of human experience. The life so imputed was human-like life. And so as an organic totality, the league of the Iroquois was conceived as an animate person or being, endowed with definite biotic properties or functions; among these characters may be mentioned male and female sex, fatherhood and motherhood, mind, eyesight, dream-power, human blood; it was also conceived as having a guardian spirit, even as its essential organic parts had. These were distinct from those possessed, or supposed to be possessed, by the persons who composed the people of the league. In the ritual of installation of chiefs, each of the constituent persons, the father and the mother principles represented in the league, is addressed as a single individual, in all of the many addresses and chants and songs. In the so-called Six Songs, which are so dramatically sung by one repsenting the dead chief to be resurrected, each of these constituent persons is addressed, but in the fifth song the Totality, the League as a Unity, is addressed as a person, for in its honor is this fifth song being sung.

Tribes of the Pacific Coast: A. L. Kroeber.

This paper analyzes a commonly accepted cul-

tural differentiation between the Indians of the narrow belt of the Pacific coast, from southern Alaska to southern California, and those of the remainder of the continent. The difference is found not to extend to specific elements of native civilization, but to consist in the use to which such specific elements are put by the two groups of peoples or the setting in which the elements are placed. The difference is traceable in material aspects of culture, such as agriculture and the art of pottery-making, and in non-material, as political organization, the employment of property, and ritualistic expression in religion.

While the culture of the Pacific coast tribes thus forms a well-marked unit distinct from the comparatively uniform culture of the remainder of America, it does not reveal any indications of definite connection with Asiatic civilizations, either in type or in source. Its origins must be sought in America. When the extreme and puzzling linguistic diversity of the Pacific coast is examined, in the light of recent comparative philological studies, this diversity appears to be not fundamental, but the result of a differentiating inclination connected with the peculiar type of political organization on the Pacific coast. The linguistic relationships also indicate that the Pacific coast has long been a fairly defined historical area, whose development and population have proceeded at least for several thousand years, from within rather than by importation and immigration.

The Relationship Terms of the Crow and Hidatsa Indians: ROBERT H. LOWIE.

The various principles determining the development of kinship terminologies have become clear through the writings of Morgan, Rivers and others. The time has now come for testing their relative efficacy in concrete instances and within restricted areas. More particularly is it desirable to compare the nomenclatures of very closely related tribes and to correlate empirically observed changes with probable causes. The Crow and Hidatsa systems furnish an instructive case in point. While on the one hand they bear clear evidence of the operation of sociological factors, in fundamental features common to both, the minor variations are not reducible to such causes, and must be referred to the psychologico-linguistic agencies of Kroeber.

The Sacred Literature of the Cherokee: JAMES MOONEY.

The Cherokee Indians were the aboriginal mountaineers of the southern Alleghanies, holding undisputed possession of a territory of some 40,000 square miles, with a population of about 25,000, being numerically, historically and culturally the most important single tribe within the United States. In 1838 the bulk of the tribe removed to what is now Oklahoma, but some 1,800 still remain in their native mountains, keeping up fairly well their purity of blood and their ancient languages and customs. Their native culture reached its highest point with the invention of the Cherokee syllabic alphabet by a mixed-blood of the tribe about the year 1820. The system was at once adopted by them for purposes of book and newspaper publication, current record and correspondence, and even as a medium of instruction in their schools. At the same time their priests and doctors seized the opportunity to preserve in permanent form for their own secret use the ritualistic formulas and occult knowledge which had hitherto been transmitted orally and confined to the keeping of initiates of exceptional power of memory.

In a study of the tribe extending at intervals over a period of thirty years Mr. Mooney has been so fortunate as to obtain the original Cherokee manuscripts embodying virtually the whole of this ancient ritual, as recorded by noted priests dead many years ago. They cover the whole range of Indian interest—war, love, hunting, fishing, agriculture, gaming and medicine—and are without parallel as a revelation of the Indian spiritual idea. The expression of the formulas is archaic and symbolic, and frequently of high degree of poetic beauty. Mr. Mooney has them now in preparation for publication by the Bureau of American Ethnology.

Sauk and Fox Notes: TRUMAN MICHELSON.

The writer's phonetic scheme of the Fox dialect differs in certain respects from that of the late Dr. William Jones. These differences consist mainly in the position of the accent, the quantity of vowels, the quality of *o* and *u* vowels, and aspirations. Some of these differences can be explained if we assume that Dr. Jones was influenced by the Sauk dialect. It is clear that the verbal complex will have to be viewed from a different psychological point of view than has obtained hitherto. A few obscure grammatical points have been elucidated.

The regulations concerning membership in the tribal dual division of the Sauk are not clear, whereas those governing membership in the tribal

dual division of the Foxes have been definitely ascertained. That the dual division among the Foxes is ceremonial and not merely for athletic purposes has been amply confirmed.

The ritualistic myths on the origin of sacred packs, especially those belonging to entire gentes, are all of one and the same type. They were doubtless invented in the remote past to account for existing ceremonies.

Le Verbe dans les Adjectifs et les Adverbes Porteurs: A. G. Morice.

In the Carrier (Porteur) dialect of the Dene language there is scarcely any regular adjective in our sense of the word. Practically all the qualificative adjectives are regular verbs, which may be divided into primary and secondary. The former have several forms that change not only according to the nature of the nouns they qualify, but also when they imply some comparison. Besides those two categories, the Carrier language contains also a third class of verbal adjectives, which may be called composite adjectives, and are distinguishable by their being made up of an impersonal verb and a pronominal prefix. A few adverbs are likewise occasionally conjugated.

Terms of Relationship and the Levirate: E. Sapir.

Evidence has recently been adduced from Melanesia and other parts of the world to show that specific features of relationship systems are frequently explainable as due to definite types of marriage. Evidence here presented from aboriginal America shows that in some systems certain relationship terms imply the custom of the levirate, that is, the marrying of the deceased wife's sister, and its correlate, the marrying of the deceased husband's brother.

The North Building of the Great Ball Court, Chichen Itza, Yucatan: Adela Breton.

The detached building (called Chamber C in Dr. A. P. Maudslay's survey) at the northern end of the great Ball Court had a single long, narrow chamber, the inner walls covered with sculptured human figures in relief. These are of great interest and appear much older than those of Chamber E, below Temple A (the Temple of the Tigers). Although part of the vaulted roof remains, and though hardest limestone was used, it is so weathered that prolonged study is needed to see the details. The stones are not large and appear to have been removed from some other building and re-erected. Instead of the regular rows of armed warriors that cover all three walls in Chamber E, there are here two principal groups and a number of detached figures conversing, in twos and threes, whose relation to the whole is difficult to understand. At the base of the walls is a flowery border, separated by a blue band from the figures, and the colors were still visible in this border in 1902. The recumbent personage of the paintings in Temple A occupies the center. Above, there is first a sort of altar with an animal laid on it and five chiefs standing on either side. The next set higher has a seated chief with the feathered rattlesnake. Facing him stands a being in a garment of scales and surrounded by flames or tongues. Five chiefs on either side, seated on round stools and carrying atlatls, complete this group. The sculptures on the two round columns which divide the entrance are particularly fine.

Excavation in the center of the chamber floor exposed a massive round stone cist with heavy cover finely wrought.

Pocomchi Notes: Adela Breton.

The Berendt manuscript collection in the library of the University Museum of Philadelphia contains three "Doctrinas" in Pocomchi, a volume of sermons at Tactic, 1818–20, with Spanish translations, a confesionario of 1814, and a fragmentary original vocabulary. The "Doctrinas" can be studied only by making a parallel copy of the three, so that the varieties of misspelling may be compared. One is dated 1741, by H. Aguilera, Cura of Tactic, but is a poor copy. Another is a copy from a manuscript at Tactic of 1810. The third is evidently taken from that, and is in Villacorta's "Doctrina en lengua Castellana Quekchi y Pocomchi," made at Coban, 1875. The ignorance of the copyists is well shown in these.

Thomas Gage, the Dominican who was in Guatemala for several years about 1680, was advised to study Pocomchi as it was most spoken about there and in Vera Paz, Salvador. He calls it Pocomchi or Pocoman and most elegant. In three months he learned enough to be able to preach. The rudiments given in his work served Dr. Stoll in his study of the modern language, but this differs much from the vocabulary. Gage was intimate with Moran, who may have written the vocabulary. This consists of 290 closely written pages, portions of original volumes many times larger. The writer was living at San Cristobal Cahcoh, near Coban, and introduces much information as to the character and habits of the people. Knowledge of ancient customs was disappearing. They no longer used stone axes nor trumpets made from calabashes, and only a few remember the name Poytan

for wall-coverings or tapestries, such as were seen in dwellings of rich Spaniards in the capital. In 1814 they still believed in dreams, wizards and the power to change into animals.

The great variety of suffixes used with numerals is a striking feature. The highest named number was 160,000 with multiples. There was no word for temple. In relationship, brother and first cousin were expressed by the same term. The writer mentions Pocoman only as the name of the people. He quotes constantly from Padre Viana's "Vita Christiani."

Some Aspects of the Land as a Factor in Mexican History: LEON DOMINIAN.

The relief of the land has afforded certain lines of easiest access to the plateau region. The line of advance of the Mexicans in the course of their early migrations, the routes followed by the white man in modern times, and railway penetration have all been determined by preexisting natural routes. Settlement has taken place mainly on the plateau and above the 4,000-foot contour. This region constitutes the only favorable human habitat within present Mexican territory, hence is explained the excess of population and of the existence of the larger cities on the plateau. Physical conditions within this tableland have affected the social status of the inhabitants at all times. The want of political union found by Cortes and manifest throughout known Mexican history is largely the result of the conspicuous lack of means of communication. Navigable rivers are not found in Mexico, while the mountainous and intermontane regions are characterized by a succession of narrow valleys, each practically walled up from the others by intervening ridges over which travel is arduous. In the same way the Mexican form of land tenure can be traced to the occurrence of large arid areas. The inhabitants of the three tierras reflect respectively the conditions which surround them. From the standpoint of continental relations, Mexico is a transition zone, both physical and human. In the former case the salient features of North American physiography are prolonged into Mexico to end in the vicinity of the Isthmus of Tehuantepec. In the latter the country can be considered as the link connecting Anglo-Saxon and Latin America.

Incense Burners from a Cave near Orizaba: H. NEWELL WARDLE.

The Lamborn Collection of the Academy of Natural Sciences of Philadelphia contains four curious earthenware beasts, found in a cave near Orizaba, Mexico. Two of the monsters have supported incense-pans, and two were probably attached to and form a part of such cultus objects of a cave temple. The types are believed to be previously undescribed, but show affinities both in form and in style of art to the cultus objects from the ancient religious center of Chavelá, Guatemala. Their relationship to the distribution and significance of the cave god is briefly considered.

The Rain Ceremony as Practised to-day by the Maya Indians of Southern Yucatan and Northern British Honduras: THOMAS GANN.

The paper describes the ceremony as practised by the Santa Cruz, Icaiche and Xcanha Indians, and the mixed Indians inhabiting the northern portion of British Honduras, and indicates points of resemblance between the ceremony and various ceremonial religious procedures of the Maya of Yucatan at the time of the conquest, as well as of the modern Lacandon Indians.

Climatic Changes and Maya Civilization: ELLSWORTH HUNTINGTON.

In the search for the causes of the rise and fall of civilization the Maya hold a peculiarly important place, since they afford an independent American means of testing conclusions reached in the Old World. Perhaps the most striking fact about the Maya civilization is that it developed in a region where agriculture is to-day extremely difficult or well-nigh impossible, where tropical fevers are at their worst, where the hot, damp climate is in itself highly enervating, and where neither the natives nor the people of Spanish descent have been able to make any progress. In the better climate of the Yucatan coast and of the Guatemalan plateau, however, the physical conditions are far more favorable, and a certain amount of progress can now be seen. This suggests that when the Maya flourished the climate can scarcely have been so unfavorable as at present.

In the corresponding parts of Asia, that is in Indo-China and the East Indies, similar ruins are found in a similar geographical environment. Farther north in the desert belt of both America and Asia there is abundant evidence of an irregular shifting backward and forward of the rainy conditions of the temperate zone into and out of the present arid regions. This process would naturally force the dry belt alternately to invade the Maya region, causing dry conditions favorable to the civilization, and to retreat from it, causing the present unfavorable conditions. Recent investigations of the chemical history of the salt lakes of

California and Nevada have greatly strengthened this "pulsatory" hypothesis, as it is called. If the hypothesis is well grounded, the course of history in all parts of the world must have been profoundly modified by repeated climatic changes which have been powerful factors in the fall of civilization at certain times and its rapid development at others. Thus the correct interpretation of the general course of Maya history, and especially the establishment of an unimpeachable chronology, assumes added importance. It will furnish one of the most critical tests of an hypothesis which, if true, will demand a widespread remodeling of the established ideas as to the conditions necessary to the advancement of civilization.

The Hotun as the Principal Chronological Unit of the Old Maya Empire: Sylvanus Griswold Morley.

Nine years ago attention was attracted by a certain periodicity in the occurrence of the dated monuments at Quirigua, eastern Guatemala, a condition previously noted but not at that time definitely established.

The Quirigua monuments were found to follow each other at intervals of 1,800 days, and, although the sequence was then incomplete, subsequent studies at the ruins in 1910–14 have resulted in filling all the lacunae, and in finding a corresponding monument for every 1,800-day period during which the city seems to have been occupied.

Later investigations, particularly during the last two years, at all the principal Old Empire sites, amply established the former prevalence of this same periodicity in the occurrence of the dated monuments, and furthermore have resulted in the identification of the glyph for this 1,800-day period for which the name *hotun* is here suggested, as well as that for the 3,600-day period for which the name *lahuntun* is suggested. Indeed the practise seems to have been so universal during the Old Empire that it is possible to formulate the following general thesis based upon it:

The stela type of monument seems to have been used primarily to record the passage of time, stelae being erected at intervals of every *hotun* (1,800 days), or even multiples thereof, as *lahuntuns* (3,600 days), or *katuns* (7,200 days), throughout the Old Empire, approximately A.D. 200 to A.D. 600.

The paper offers this thesis to Maya archeologists, and presents coincidently a partial summary of the evidence on which it is based, illustrated with photographs, maps and diagrams.

The Chilam Balam Books and the Possibility of their Translation: Alfred M. Tozzer.

Owing to the large amount of original manuscript material made available during the last two years by Professor William E. Gates, a great opportunity is offered to Maya students for the study and translation of the Chilam Balam books. With photographic copies of the Motul and San Francisco dictionaries, and copies of all the known original Chilam Balam books, one has for the first time the material at his disposal.

As Brinton remarked many years ago, "The task of deciphering these manuscripts is by no means a light one." The importance of the results which may be expected should serve as a powerful incentive to all Maya students. The task is not an impossible one. There are certainly some passages which will never be translated. The books, as they now appear, are copies made chiefly in the eighteenth century or earlier works going back in some cases probably to the sixteenth century. The text as a consequence has suffered badly. The copyist shows in many cases an ignorance of Maya, and, in some instances, a surprising ignorance of Spanish. In several cases Latin words appear in an almost unrecognizable form. The Maya is most arbitrarily separated into several different ways on the same page. The punctuation is also never consistent.

The few passages already translated show the great importance attached to the manuscripts. The chronological parts have already served to make possible the coordination of Maya and Christian chronology. These portions are, of course, of primary importance. The parts dealing with prophecies and the good and bad days of a year are other parts worthy of study. There is much that is almost entirely Spanish in character, with little reflection of the native element. The medical parts figure largely in many of the manuscripts. In most cases the directions for curing various kinds of illness are entirely Spanish in origin. The Christian teaching with the "Doctrinas," the astrological information, and discussion of the Zodiac, as in the Kaua manuscript, have little of interest for students of precolumbian history as compared with those portions dealing with the ancient chronology and the history of the wanderings of the Maya.

In addition to the translations, a careful collation of the material from all the manuscripts is absolutely necessary. The reconciliation of the various statements regarding similar events in the

different books will be no less difficult than the simple translation of the Maya text.

Recent Progress in the Study of Maya Art: HERBERT J. SPINDEN.

The historical arrangement of sculptures at Copan has now been reduced to great certainty, and there is hardly a monument that after examination of the carving can not be dated within twenty years. Mr. S. G. Morley has succeeded in deciphering most of the inscriptions, and there is entire agreement between the dates and the stylistic sequence. At cities that flourished in the Great Period (455–600 A.D.) the criterion of sequence is seen mostly in the progressive elaboration of designs by flamboyant details. It is necessary to treat homogeneous material. At Quirigua the faces carved on the tops of the bowlder altars furnish an interesting series. At Naranjo the ceremonial bar passes from comparative simplicity to extreme complexity, and the change is in accordance with the inscribed dates. Piedras Negras proved to be the most interesting of the sites visited by Mr. Morley and the writer in 1914. The monuments give an especially full account of the Middle Period and extend well into the Great Period. Four monuments, representing the same subject, with considerable intervals of time, show a remarkable increase in design elaboration.

In spite of provincialism that appears in some sites we are now able to strike the general levels of artistic development in practically all Maya cities of the First Empire (200–600 A.D.). Progressive changes in the construction and ornamentation of buildings is seen very clearly at Yaxchilan. The most interesting problems are those of roof-comb support and the origin of the sanctuary. Several Yaxchilan temples have dated lintels which bring the sequence in architecture in touch with sequence in sculpture.

On the Origin and Distribution of Agriculture in America: HERBERT J. SPINDEN.

Without agriculture none of the high civilizations of the New World would have been possible. Agriculture was independently developed in America because the plants under domestication are different from those of the Old World. It probably had one point of actual origin and that was in the region where maize grew wild. This region was pretty clearly the highlands of Mexico and Central America. Maize, with beans and squashes, are found throughout the area of agriculture. Secondary centers in which special plants were brought under cultivation are seen in Peru, the lower Amazon valley, etc. In the region north of Mexico all cultivated plants (except tobacco) were introduced, and none is indigenous; therefore the pueblo and mound cultures are not strictly autocthonous.

Pottery and weaving are practically dependent on agriculture. The earliest pottery of Mexico—that of the so-called Archaic culture—seems to have developed soon after the rise of agriculture and to have been carried well into South America with the same cultural stream that carried agriculture. A peculiar technique can be traced without change to the Isthmian region, and with progressive modifications, under which the original features can still be seen, it can be traced to southern Colombia and well into Venezuela.

Résumé of Recent Excavations in Northern Yucatan: EDWARD H. THOMPSON.

A résumé of the excavations conducted in and about northern Yucatan up to the time of the first Peabody Expedition of Harvard University to explore the Cave of Soltun and the ancient group of Sabná.

Sabná, the first ruin group on the peninsula of Yucatan to be scientifically excavated and surveyed. Detailed methods described, and some of the interesting results obtained.

Kichmook, the second ruin group on the peninsula to be systematically excavated and scientifically studied.

Excavation, conducted subsequently to those above named, in the ancient sites of Chichen Itza, Mayapan, Acanceh, Tiho, etc.

The Maya Zodiac of Santa Rita: STANSBURY HAGAR.

A number of years ago Dr. Thomas Cann excavated on the estate of Santa Rita, near Corozal, in British Honduras, a rectangular building, the walls of which were covered with stucco paintings of the pre-Cortesian period. Those on the north will present a continuous series of Munan figures associated with conventional symbols of glyphs, and some of them holding a rope. The whole may be interpreted as a picture of the cosmos with the sky and stars above, the earth below, and the waters under all. The figures and symbols repeat the zodiacal sequence found in the constellations of Tezozomoc, Sahagun and Duran, the Maya day-signs, the paintings at Mitla and Acanceh, the various pictorial sequences in the codices. They seem, therefore, to represent the asterisms, deities and day-signs of the Maya zodiac in a correct and continuous sequence, the rope being that of the ecliptic or zodiac. A Nahua element is prominent

in this zodiac, and its symbols reveal intimate correspondence with those of other native zodiacs in Yucatan, Mexico and Peru; also in lesser degree with the zodiac which we have received from the prehistoric Orient.

Archeological Studies in Northwestern Honduras: MARSHALL H. SAVILLE.

During the summer of 1915 the writer and his son made a reconnaissance in the department of Cortés, Honduras. An examination was made of the archeological conditions along the Ulua River, previously reported on by Gordon. An important collection of antiquities was brought together illustrating the complex features of this section of Central America, objects of several well-known and far-distant cultures being found in the restricted area of the broad valley in which flows both the Ulua and Chamelicon rivers. Pottery vessels recalling Tarascan, Nahuan, Costa Rican and Colombian ware in shape and decoration were found, as well as the characteristically Mayan type of polychrome and undecorated vessels. Jadeite ornaments of unquestioned Costa Rican origin occur, and two well-defined examples of the "palma-stones" of the Totonacan class of sculptures of Vera Cruz were collected.

In the mountains toward the department of Santa Barbara, several large groups of mounds were visited, the unknown groups of Manchagualla and Chasnigua being of particular interest for further investigation and excavation. Mounds and village sites were found also near the borders of Lake Yojoa.

It is the intention of the Museum of the American Indian in New York to make a survey of Mosquitia, the region lying along the Caribbean Sea, from the vicinity of the mouth of the Ulua River to Bluefields, embracing a vast strip of territory, partly in Honduras, partly in Nicaragua. This area is little known geographically, and less so archeologically. Information was obtained showing Nicaraguan and Costa Rican resemblances in the antiquities, such as animal-shaped metates and stools, reported in this country, and shown by several examples in the collections of the Museum of the American Indian, collected many years ago by the late Dr. Joseph Jones.

GEORGE GRANT MACCURDY,
(To be continued) *Secretary*

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 554th regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, April 8, 1916, called to order by President Hay at 8 P.M. with 65 persons present.

The president called attention to the recent death of Wells W. Cooke, treasurer of the society, and announced the appointment of Messrs. Hollister, Gidley and Wetmore to draw up appropriate resolutions.

The president also announced that the council had elected Dr. Ned Dearborn to the vacancy caused by treasurer Cooke's death, and also of his appointment to the committee on publications.

On recommendation of the council the following persons were elected to active membership: Robert M. Libbey, Washington, D. C., G. K. Noble, Museum of Comparative Zoology, Cambridge, Mass., and Dr. Howard E. Ames, U. S. Navy (retired).

The following informal communications were made:

Dr. R. W. Shufeldt commented upon and exhibited specimens of a Japanese salamander, *Diemictylus pyrrhogaster*, obtained from a local dealer in live animals.

Dr. Paul Bartsch called attention to the introduction of European agate snail *Rumina decollata* in certain parts of the southern states; and to the recent publication by J. B. Henderson of a book entitled: "The Cruise of the *Tomas Barrera*," the narration of a scientific expedition to western Cuba and the Colorados Reefs, with observations on the geology, fauna and flora of the region.

Dr. M. W. Lyon, Jr., made remarks on the history of the *Filaria bancrofti* embryos exhibited at the previous meeting of the society.

Mr. F. Knab discussed the mosquito host of *Filaria bancrofti*, saying that an appropriate species of *Culex* is found in Washington in the late summer.

The regular program was an illustrated lecture by Mr. Edmund Heller entitled "Hunting in the Peruvian Andes." Mr. Heller gave an account of a recent collecting trip made by him from the west coast of Peru up into the high Andes and down to the headwaters of the Amazon. He described the animals collected, mainly mammals, but also birds and reptiles, including the rare spectacled bear, wild llamas, etc. He also commented on the habits and customs of the natives. He showed photographic lantern slides not only of the wild life, the inhabitants and physiographic features but also of many points of archeological interest.

M. W. LYON, JR.,
Recording Secretary

SCIENCE

FRIDAY, JUNE 16, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN CHEMIST AND THE WAR'S PROBLEMS[1]

A VOLUME could be written upon this subject if one possessed the power to assemble the material. The new problems which have arisen; the old ones which have become acute because of changed conditions; the splendid way in which the problems have been met where they were a matter of invention or skill; the new methods and processes which have sprung up as though born fullgrown; the many old ones which have been improved, altered and utilized in new connections; the way in which the chemists of the country have risen to emergencies which have compelled them to manufacture products in whose manufacture they had had no prior experience, would easily fill entire chapters in such a volume. Even so, no earthly progress, achievement or consideration can lift the pall which settles over us when we permit our minds to dwell upon the spectacle of this war. And whose mind can be diverted from it for any length of time? He must indeed exist far below the kindling-point who does not resent and despise with all his soul the philosophy and ideals which made it possible. It would be out of place therefore to consider our subject from the point of view of achievement, or felicitation, on any alleged good which has come to the science of chemistry because of the war. Surely no one would want progress at such a cost to his fellow man. We approach the subject rather in a spirit of thankfulness that we have been enabled to

[1] Address before Section C, American Association for the Advancement of Science, Columbus meeting, December 30, 1915.

save something out of the wreck, and that our experience had prepared us in advance so that we have been enabled to prevent the collateral business and economic tragedies of the war from spreading universally. It is not in any spirit of gladness, therefore, at the evil providence which has fallen upon our European neighbors, that we recognize that this war has exalted the importance of chemistry in the minds of those who had not much opportunity hitherto to appreciate its value, nor is it with any jubilation that we take pleasure as chemists in meeting our new problems and emergencies arising from the war.

The satisfaction to many industrial chemists in the last two years of being able to contribute to the solution of these problems and of being conscious of the salvation of many businesses from financial ruin through the exercise of their chemical experience, has seldom been so widely distributed as it now is. What an inspiration it would be to read, spread out upon the pages of such a book as we have mentioned, the chemical successes, big and little, of the past two years. It is not likely that many of them will be known for a while because of the fact that business caution forbids their publicity in many cases, and the vigorous campaign of destruction of equipment and diversion of supplies which stops at nothing which will hamper export from this country, makes silence a necessity in self-defense.

The problems of the war are of two kinds, those due to changed conditions and those arising from supplying munitions at high speed. Among the former are changes in raw materials made necessary by the failure of imports or by unusual consumption of raw material in other channels such as for products not heretofore manufactured in this country to the extent made necessary under present war conditions. These changed circumstances were also due in part to new demands for materials and products, which have arisen in the complete rearrangement of things that has come about in many circles since the war began. The other line of war problems which have arisen, those directly connected with munitions supply, are frequently of a difficult nature. All these various problems, however, have been met in practically every case with a degree of success which has surprised even ourselves.

Naturally one of the first serious effects of the war on American industries was the stagnation produced by the enforced cessation of exports in various lines. Such things as rosin, turpentine, petroleum products, acetate of lime and methyl alcohol were seriously affected for a varying length of time. Then the demand for munitions became, for instance, the wood distillation industry's salvation and, with great celerity, acetone plants were attached to many of the works of this industry and the high prices which the products of the industry demanded have brought unprecedented prosperity to it and have correspondingly hampered progressive improvement. Production, not efficiency, is at present the slogan for this and many other industries. Set-backs of the nature cited usually take time for readjustment and frequently the chemist is a material factor therein. The producer himself is often compelled to add the next manufacturing step to his own operations. The acetate maker, for instance, tends to enter acetone manufacturing. Where the new demands were ample, these attempts have succeeded and the war's conclusion will find an increased tendency to manufacture at the source.

The set-backs to industry arising from the disturbance in exports, while they were important financially, were minor matters compared with those arising from such

changed conditions as failure of raw materials or their curtailment by absorption in new or abnormally expanded industries. It is here that the chemist is needed most and it is here that he has been of immeasurable service, and has met the problems that have arisen in wonderful style. He was seriously hampered at first by the uncertainty as to the facts. The fundamental thing in every industry is the market. At first much damage was wrought and delay produced by false reports as to stocks on hand and supply, particularly, of imports. Much withholding of goods for higher prices was practised and even yet the pirates of commerce seek ways and means of evading contracts, even on deliveries of goods which they were receiving without cessation, so as to avail themselves of the inflated market prices. Some clever work by consumers trapped at least some of these unscrupulous brokers and sellers. All manner of fictitious prices were demanded of those unfamiliar with the facts and attempts were even made to influence the Washington government to activity against the British blockade through the use of untruthful statistics regarding dyes.

As soon as the true status of market and supply became reasonably certain many changes were effected which will give gradual, and probably ultimate relief. On every hand we see chemical activity without end. Products like synthetic phenol and barium salts not made in this country before the war are now made in large amount. Great expansion in production has taken place in the case of such material as benzol, toluol, aniline products, naphthaline, carbon-tetra-chloride, acids, alkalis, chlorates, bichromates and even oxalic acid. With all of these we were largely or in part dependent on imports, but have almost ceased to be so since the war began. Fertilizer plants erect their own sulfuric-acid works and insecticide makers their own arsenic-acid plants. Textile mills make their own bleach. Numbers of manufacturers replace potash compounds by sodium compounds and, to my own surprise at least, often with great improvement in results. The ceramist is rendering this country less and less dependent upon imports in that field by scientific purification and utilization of domestic clays. Manufacturers of numerous miscellaneous chemicals and pharmaceutical preparations proceed to refine and produce their own crude raw materials and intermediates. The dye famine—for it is real in certain quarters—stirs up corporations with capital of hundreds of millions to enter the field. One of these new companies has installed half a million worth of machinery in the last few weeks. Indigo and other dyes are being made in nearly half-ton batches which will soon expand to several ton size. Where formerly was the most peaceful of occupations, even fertilizer manufacture, every effort now goes to the making of munitions. New plants spring up at the beck and call of the new conditions such as the world has never seen. Think of a battery of one hundred nitric-acid stills each charging 4,000 lbs. of sodium nitrate three times a day. Think of the sulfuric acid required and the nitric acid produced. Think of the fact that this one of a number such (the largest nitric acid plant in the world, it is said) is a plant which a year ago did not exist except in the minds and plans of a group of chemical engineers. How little are we able to comprehend the reality of producing 1,000,000 pounds per day of gun-cotton where a year ago was merely pine-woods. What does it mean with reference to design of plant, erection and operation to any one who has not managed chemical engineering operations, to recount the engineering operations in-

volved in this enormous production of gun-cotton in a single plant?—work that is conducted in ten to fifteen parallel procedures or "cotton-lines," which with their accompanying accessories, include cleaning and alkali digestion of the cotton; bleaching with chloride of lime; manufacture of sulfuric acid for the production of nitric acid and "mixed acid"; nitration of the cotton in thirty-pound batches; the hazardous wringing and hasty submerging of the cotton in water, to avoid the consequences of heating by too slow dilution of the strong acid held spongelike by the cotton; the conveying of this material in the cotton-line to the washers where the remaining acid in the tube-shaped cotton fibers is removed; and finally the removal from the water as wet or damp gun-cotton, the commercial product of many plants. This end product of course is but the beginning or raw material for the various nitro-celluloses, smokeless powders and other high explosives. Yet this scale of operations is not going on in just one plant of this kind or even in this one industry. *This* is a sample of what is happening every day in the shape of the American chemical engineers' answer to the question, how are you meeting the war's problems?

At some of these things we are permitted to take at least a peep. No one man can know all of even such gross developments, and practically every chemist we meet has his enthusiastic story of the progress in his own and familiar fields. We all do know, however, that if this is the character of the outward developments, there must be legions of quiet research and other experimental attacks on the new problems, and literally hundreds of solutions being worked out for minor problems in factory and plant, not to speak of the vast amount of work in other departments of chemistry made necessary by all these things. Then, too, there is the ever verdant crop of interesting suggestions, revolutionary changes and inventions throughout the list of the chemical industries. In fact they are doubly numerous and aggressive under the stimulation of such a time as this. It is never wise to predict their success or failure until even years have elapsed in many cases. So that the lecturer who wishes to entertain his hearers with pleasant and surprising intellectual gymnastics in the shape of the newest and most wonderful achievements in industrial chemistry is safe from apparent error for from three months to three years, if he picks his illustrations well. At the end of that time he can dodge criticism for misjudgment by referring the back-fires to poor business management, insufficient capital, tariff, trusts and sometimes to poor engineering. It is true that a large number of these new things *never* make good. It is equally true that some of them will make good and that all of them indicate progress, for they are strivings, and progress comes by striving.

It is equally true also that many of the chemical expedients which are in successful use under war conditions will automatically step aside when normal conditions resume. It is fundamental industrial chemical intelligence that a procedure which is ridiculous under some conditions may be a God-send under others. We do not expect every change installed to be really normal progress, for it will not be so in the ordinary sense at least. On the other hand, it would be wrong also to say that the mushroom plants producing munitions are not signs of progress. They unquestionably are not such signs in as far as they are temporary. They do not measure true expansion in their respective fields. He would be a novice or singularly blind, however, who did not see that the construction of such plants on the undreamed-of scale I

have already mentioned, not to talk of the new materials and procedures which have been incorporated into many of them, makes for greatly enlarged experience in chemical engineering designing, construction and operation. It is easy to see the pressure these things are going to exert upon the future development of American chemical industries. The American chemist's experience is becoming greatly expanded and the significance of this is apparent when we consider that engineering progress is a function of demand, and skill or experience in solving problems. The demand increment is ever expanding with the development of the country. In addition the skill acquired in the production of munitions is a valuable potential asset for defense should such a necessity ever arise. Such preparedness is highly to be desired. Then too at the close of the war when the output of these plants is no longer needed for that purpose, their equipment and intelligence will be directed into whatever field promises most. Already some of these concerns are assured that some of their products will find a continuous demand after munitions manufacturing ceases, which will be some little time after actual hostilities are at an end. The field of dye production is already attracting some of them. Without doubt the industrial rearrangements to follow the war will leave us much better situated in our ability to cope with the problems of chemical production. At any rate, powerful financial interests will attack these problems as they never have been attacked before. These interests will constitute another great force, which will be particularly effective after the war. When they seek new outlets for materials such as alcohol, benzol and acids, whose production they are greatly accelerating at the present the gasoline and other problems will be greatly affected. These interests will be found after the war lined up behind the industrial chemists who have been struggling for years against all kinds of unfair competition and disreputable depreciation. Then again, any change in process, be it ever so time-worn chemistry or transient in its nature, if it actually is put into successful operation under the then existing conditions, must of necessity push out the boundaries of experience to greater and greater distances and make us better able to meet the problems of the future. Chemical engineering is like any other division of engineering, it grows by what it accomplishes. In this proof of ability to meet a transient emergency the American chemist is certainly reaping a hundredfold, from his unadvertised care in the meeting of his industrial problems of the years which have gone before. Individual cases of progress and development which I have mentioned, it is easily seen, are rarely of great importance in themselves. We have not been revolutionizing on a great scale nor have we been jumping at once into great new national industries, but we are rather directing the normal steady gait of our progressive industrial development with keener perception toward more complete self-containedness, and thorough industrial preparedness. Some of the industries mentioned which receive much public attention are of relatively little importance compared with many other items affected. The dyestuff shortage appears to annoy many, but the complaint is out of all proportion to the facts and the damage done, compared with that of other commodities. We import normally, for instance, $9,000,000 in coal-tar dyes per annum and if we should make them all ourselves—which we shall only gradually approximate—we should only increase our chemical manufactures two per cent. and

our total manufactures five one-hundredths of one per cent.

Though we have made reasonable headway on our problems we are keenly aware that much remains to be done. We do not expect to set the market right in the dye or other matters in a year or two. These developments take time and have always taken time. Neither should we deceive ourselves or the public into thinking because of what we are doing that we could turn out without the most careful and detailed previous planning, adequate munitions for our own defense "in sixty days" to supply the "two million men who would spring to arms" as we so often hear would happen in that undesired emergency.

It would be interesting to discuss in detail some of the transient as well as probably permanent advances, where they happen to be a matter of personal knowledge, if it were wise to hand information to the assassins who lie in wait to hamper some of them, for military reasons. It might be well therefore to spend just a little time in emphasizing some general considerations which are connected with this subject.

There is little use in attempting to disguise the fact that the present war is a struggle between the industrial chemical and chemical engineering genius of the Central Powers and that of the rest of the world. Quite irrespective of the war's origin, aims, ideals or political circumstances, these are the cohorts from which each side derives its power.

When we consider the strategic position of the Central Powers themselves, their capable education and training, their system of government, which, no matter what we may think of its selfish effect on the world as a whole, we must admit makes for more effective concentration upon its own governmental objectives, among which preparation for war is merely one of its manifestations—when we take into account all these things it must often appear to us that the greatest outstanding feature of the past two years is the miracle of the Entente Powers' resistance to the terribly efficiently prepared onslaught of the Central Powers. This resistance is due, to an extremely large extent, to the efficiency of the chemists of the neutral and Entente nations. The chemists of the Entente Powers and of America have arisen to the emergency as no chemists have ever done before in the history of the world. Confronted at the beginning of the war by antagonists whose munitions industry for years had been developed for just such a contingency, these chemists have in less than two years built up a rival industry at least as strong. Plant after plant has sprung up of such perfection of design and operation that one wonders how the mind of man was capable of such engineering. Though the speed with which these new and unexpected problems have been solved may appear surprising, no one who is informed about the progress and development of industrial chemistry in this country, could have reason to doubt that American chemical engineers and industrial chemists would rise to any emergency which it was within human power to meet. They have already and will continue to live up to what we have a right to expect of them, in view of their past successes. We should be surprised if a similar degree of success did not crown the efforts of the chemists of the other countries, France, Britain, Italy, Germany, Austria, Russia, for it has never been the habit of American chemists to boastingly claim superiority because of any advantage, real or imaginary, with which they, like any group, are apt to be blessed for a greater or less period of time. We have always appreciated chemical contributions to progress from whatever source they have come

and praised unstintingly the individual wherever he may be who has taken a distinct step forward, for we firmly believe this is an important help in advancing the progress of the science.

These general developments are naturally not a matter of public information, except attention is called to them. The chemist works almost entirely beneath the surface of things and only in a few spectacular cases is public attention drawn to his work. It is quite natural, therefore, that appreciation and praise of foreign chemical achievement and particularly our consistent praise of German achievement to our students by our university teachers of chemistry have been misunderstood, and have prepared a fertile field for foreign propagandas to establish a false impression of the superiority of certain groups of foreign chemists. We should scarcely object to a good-natured adulation of any one's fatherland and its achievements. Such things always contain good and are stimulating to every one, and it is a pleasure to hear them when free from arrogance, even when the adulation contains little that is new or even strictly true. When, however, this privilege is abused so that the point of superiority must be made by depreciating American efforts it has a vicious positive result upon the minds of the uninformed, and at times causes great financial loss to them.

If the shortcomings of American chemistry were frankly discussed and compared with foreign successes in a chemical publication, some help might thereby be given to those who could derive benefit from it. When this is *not* frankly done, but simply issued as an incidental *depreciation* of American chemistry, particularly when discussing foreign chemical achievement, and still worse when in a non-chemical publication, the object can scarcely be rated as creditable.

A good illustration of this is an article published by the *Review of Reviews* for August, 1915, upon "What German Chemists are Doing to make Germany Self-sustaining," by Hugo Schweitzer, who, the editor humanely states, is an American chemist. Considering the avowed purpose of the article as attempting to influence American public opinion to stop "*all* exports to *all* belligerent nations," the article gives an interesting appreciation of the German chemist's efforts to meet their present problem, but commences to wind up as follows.

> Thus the horrors of war, through the ingenuity of the German chemists, are promoting the legitimate industry of the nation, rendering it more and more independent of foreign conditions, and keeping in the country vast sums formerly spent for imports. *Unfortunately and unexpectedly we can not record similar advantages for the United States, although we are enjoying peace.*

The inaccuracy of the last statement we hope is no measure of the truthfulness of the article as a whole. If the myth of the overwhelming industrial chemical superiority of German chemists ever was really believed, in that country, the military forces of the Central Powers at least must marvel at the reason the supposedly inferior foreign industrial chemists have been able to display such astounding ability and speed in meeting the problems of munitions production, particularly too in countries where governmental mobilization of industries was unknown before the war and, in America at least, still is unknown. At any rate, it has become evident that lack of advertisement is no sign of lack of ability or activity, and that ability to handle science skillfully and powerfully is not confined to any race or nation. We do not feel that there is much to be gained by confuting claims of the chemical superiority of foreign countries in this and other similar articles, for it is curious how this war has developed

foresightedness to the extent that such *Americans* can see only the chemical develments abroad.

I hope I have made it clear that it is the abuse of a privilege against which I speak, and not against individuals, for we do not let such personal attacks affect our regard for individual Germans any more than we allow our opinions on the history of the past two years to affect this regard for such individuals. Every one of us know Germans who are the most whole-souled and kindly men—who we are grateful to know and who scorn to be guilty of, or to take advantage of, such chauvinism. Such depreciations of American efforts will bury themselves, without any assistance from us, and I only emphasize them here to call attention of teachers of chemistry to the fact that *we* owe protection to the business community and the public against such misrepresentation. We should never cease our appreciation of foreign chemists of whatever nation, but in addition it is our duty first to inform *ourselves* and then our students upon what our own chemists have done to solve our problems in this country. We have been able to blame our shirking this duty in the past upon the fact that it was easy to get information about foreign chemical achievement and no one seemed anxious to give publicity to American development. We as teachers have certainly done little to remedy this condition. The American Chemical Society, however, has spread the results of American effort before us and made them accessible in its *Journal of Industrial and Engineering Chemistry* for the last two years, in the shape of a series of addresses on the chemist's contributions to American industries. There are other addresses in these same volumes profoundly informing along these lines and this is particularly true of the Perkin Medal addresses each year in the same journal. In addition Professor S. P. Sadtler in the *American Journal of Pharmacy* for October, 1915 (an address before the National Exposition of Chemical Industries), in giving popular information along this line limits himself entirely to chemical industries *originated* as well as developed by American chemists, and Edgar F. Smith's "History of Chemistry in America," but recently issued, should be read by every student of chemistry.

None of this work is in any sense a vainglorious adulation of the chemist as some superbeing nor is it an attempt to compete in the questionable game of lauding one nationality above another. It is merely a matter of a belated form of education which our universities and chemists hitherto have largely denied to the American business man, and which he has a right to expect of them. The record is one for which we have good reason to be thankful and, as we teachers no longer have the excuse of ignorance about American progress, we are at fault if the rising generation has not an appreciation of the progress of chemistry in America, commensurate with the high level of its development.

In conclusion then, let us take courage from the fact that though much damage has been done to us and our industries by the war, our efforts at salvage benefit us as experience, power and preparedness. We have seen that the chemists of America have met the war situation well and do not require defense at the hands of any one. It becomes increasingly evident that business is awakened to the value of chemistry as a source of power and wealth as business has never had occasion or opportunity to be hitherto. Let us hope also that not only the spectators, but also all the combatants may learn, even if impelled by bitter war's experience, to appreciate the worth, each of the other, and that all nations are "made of one blood to dwell on the face of the earth."

James R. Withrow

DEATH RATES AND EXPECTATION OF LIFE

DIRECTOR SAM. L. ROGERS, of the Bureau of the Census, Department of Commerce, is soon to issue a unique set of tables, the first of their kind which have ever been prepared by the United States government. These tables, which were compiled in the division of vital statistics, under the supervision of Professor James W. Glover, of the University of Michigan, show death rates and expectation of life at all ages for the population of the six New England states, New York, New Jersey, Indiana, Michigan and the District of Columbia (the original death-registration states) on the basis of the population in 1910 and the mortality for the three years 1909, 1910 and 1911. They are similar to the "life tables" prepared by life insurance companies, but differ from them in that they relate to the entire population of the area covered, whereas the life insurance tables relate only to risks selected through medical examination and otherwise.

Expectation of life, at birth, in a stationary population—that is, one in which the births and deaths were equal and were the same from year to year, and in which there was no immigration or emigration—would be the same as average age at death, which is calculated by totalizing the ages of all deceased persons and dividing the result by the number of deceased persons.

According to these tables the average expectation of life, at birth, for males is 49.9 years; for females, 53.2 years; for white males, 50.2 years; for white females, 53.6 years; for native white males, 50.6 years; for native white females, 54.2 years; for Negro males, 34.1 years, and for Negro females, 37.7 years. Females are thus longer lived than males to the extent of more than 3 years, and in the case of the native whites and Negroes, more than 3½ years.

The expectation of life at the age of 1 is considerably greater than at birth, being 56.8 years for native white males and 59.5 for native white females, and reaches its maximum at the age of 2, when it is 57.5 for the former class and 60.1 for the latter. At the age of 12 the average native white male's expectation of life is 50.2 years; at 25 it is 39.4 years; at 40, 28.3 years; at 50, 21.2 years; at 60, 14.6 years; at 70, 9.1 years, and at 80, 5.2 years. Similarly, at the age of 12 the average native white female's expectation of life is 52.6 years; at 25 it is 41.8 years; at 40, 30.3 years; at 50, 22.8 years; at 60, 15.8 years; at 70, 9.8 years, and at 80, 5.5 years.

A part of the difference between expectation of life for men and for women is due to the greater number of violent deaths among men. Nearly four fifths of these violent deaths—suicides, homicides and accidental deaths—are of males, and such deaths form about 7 or 8 per cent. of the total number occurring each year. This fact, however, does not account fully, or even in major part, for the greater longevity of women. An examination of the tables discloses a lower death rate for females than for males during each of the first 12 months of life and, in the case of the native whites, during each year of life up to the age of 94. During the first month of life the death rate among native whites is nearly 28 per cent. higher for boys than for girls, and during the first year it is more than 20 per cent. higher.

The enormous waste of infant life which still goes on, although medical science has done and is doing much to arrest it, is shown by the exceedingly high death rates which prevail among infants under 1 year of age. Of 100,000 native white boy babies born alive 4,975, or almost 5 per cent., die during the first month, and 12,602, or 12.6 per cent., die within one year. The girl baby's chance of life is considerably better, the death rate among native white females during the first month being 3,894 per 100,000 born alive, or less than 4 per cent., and during the first year 10,460 per 100,000, or nearly 10.5 per cent.

On its first birthday, however, the likelihood that a child will die within the year is only about one fourth as great as it was at birth, the death rate among native whites during the second year being 2,841 per 100,000 for males and 2,610 per 100,000 for females. The

rate continues to decrease until the twelfth year of life—that is, the period between the eleventh and twelfth birthdays—during which it is only 228 per 100,000 for males and 198 per 100,000 for females. This, the figures indicate, is the healthiest year of life among native whites. Thereafter there is a continuous increase in the death rate from year to year. During the forty-eighth year of life, in the case of native white males, it is 1,267 per 100,000, or almost exactly what it was during the third year, 1,266; during the sixty-second year it is 2,919 per 100,000, or a little more than during the second year, 2,841, and during the eightieth year it is 12,184, or somewhat less than during the first year, 12,602. Similarly, among native white females the rate during the fiftieth year, 1,120, is a little less than during the third year, 1,144; during the sixty-third year it is 2,548, or somewhat less than during the second, 2,610, and during the eightieth it is 10,901 per 100,000, or a little more than during the first, 10,460. The native white man at the age of 102 and the native white woman at 99 have approximately the same prospect of dying within one month that they had at birth.

To say that a person's expectation of life is a certain number of years is not the same as saying that he has an even chance of living that number of years. This is because, as already explained, expectation of life represents the average remaining length of life, at any given age, in a stationary population, whereas an average person in a given group has an even chance of living to what is called the median age at death, that is, the age below which half of the members of that group will die. The median age at death for all native white males in the assumed stationary population would be 60; that is to say, of a given number of such males born alive, half would die before reaching 60 and the other half at 60 and beyond. A native white male child at birth, then, has one chance in two of reaching this age. At the end of his first year, however, he has a trifle better than an even chance of reaching 64; and at 42 he has one chance in two of attaining three score and ten. Similarly, a native white female child at birth has an even chance of living a few months past the age of 64; at the age of 1 she has one chance in two of living until she is nearly 68 years old; and at 22 her chance of reaching 70 is an even one. Thus a native white man at 42 and a native white woman at 22 have about the same chances of celebrating their seventieth birthdays.

The relative healthfulness of city and country is strikingly shown by the tables, according to which the death rate among white males under 1 year of age in cities having 8,000 inhabitants and over in 1909, and in cities of 10,000 and over in 1910 and 1911, is 13,380 per 100,000 born alive, whereas in smaller places the corresponding rate is only 10,326 per 100,000, or 23 per cent. less than the rate for cities. A similar difference prevails with respect to white females under 1 year of age, for whom the death rate in cities is 11,123 per 100,000 born alive, while in rural localities it is only 8,497 per 100,000, or 24 per cent. less than the urban rate.

For white males the expectation of life, at birth, in rural localities is 7.7 years greater than in cities; at the age of 10, 5.4 years greater, and until the age of 39 is reached there is a margin of more than five years in favor of the country. Thereafter the difference becomes gradually less, but is always in favor of the country until the age of 88 is reached, at and after which the cities show a slightly greater longevity than the rural localities.

For white females the difference between urban and rural longevity, while pronounced, is somewhat less than in the case of males. At birth the white female's expectation of life is 6 years greater in rural than in urban localities; at 10, 3.3 years greater, and until the age of 46 is attained the difference continues to be more than 3 years. Thereafter it declines until the age of 83 is reached, after which the cities have a slight advantage over the country.

THE IROQUOIS INDIAN GROUPS OF THE NEW YORK STATE MUSEUM

There have recently been opened for public exhibition in the New York State Museum six

life groups which have been erected for the purpose of portraying the aboriginal activities of the Iroquois, or the Confederacy of the Six Nations. The figures in these groups are life casts of the best types obtainable and each one is thus a somatic document. They have been reproduced by Caspar Mayer and Henri Marchand, sculptors. The background paintings, each 55 feet long, are of historic spots in New York Indian history, and they, together with the entire setting of the groups, are by David C. Lithgow, artist. The conception and execution of the groups and the accuracy of their composition are due to the director and the archeologist of the museum.

The groups are a gift to the State Museum from Mrs. Frederick Ferris Thompson.

Seneca Hunter Group.—With a background scene representing Canandaigua Lake and Genundewa, the sacred hill of the Senecas, in the distance, the group is that of the Seneca family clustered about the door-yard of their hunting lodge, each individual engaged in his allotted duties; the father bringing in a fawn from an early morning hunt, the mother busy skiving a deer skin, the daughter dressing and cutting venison; while the eldest son is a hunter and warrior and the younger son is cutting down a tree which obstructs the door-yard.

The Return of the Warriors.—The advance party of a Mohawk war expedition has returned to Theonondioga, the Mohawk capital, situated in 1634 just above the present village of Sprakers in the Mohawk valley, and the observer is looking north toward the foothills of the Adirondacks. The Mohawks have brought in two Mahikan captives from the vicinity of the Hudson River. The purpose of the group is to illustrate (1) the treatment of prisoners, (2) the authority of the Iroquois woman, who is by virtue of her tribal right interposing to save one of the captives from death, (3) the differences between the Mohawks and Hudson River Mahikans, (4) an Iroquois village with its stockade wall.

Council of the Turtle Clan.—The scene is laid within an elm-bark lodge typical of the habitation of the Iroquois before the coming of the whites. The figures are all Onondagas and the chiefs are engaged in trying out some important tribal subject. The one female in the group, not permitted by tribal usage to appear before the council on her own behalf, is urging her cause upon her secretary. The purpose of the group is to illustrate (1) one of the political units of the Iroquois Confederacy, (2) the interior and equipment of a bark lodge, (3) the four Turtle Clan sachems in council, (4) the method of recording by wampum the transactions of the council, (5) the privilege of an Iroquois woman to voice her opinions in the highest or lowest councils of the nation. Through the open door of the council house is a typical scene of the rough country in southern Onondaga County.

Cayuga False Face Ceremony.—This is the midwinter purification rite, when evil spirits are driven from all the houses of the Iroquois village. Grotesquely clad and masked medicine men burst into the cabins, throwing open the doors and windows, and scatter new ashes over the heads of the occupants. The Indian cabin is an old one, typical of the period of 1687–1850, when the New York Indians had become accustomed to traders' cloth and tools. The clothing of the figures, made of trade cloth highly embroidered by symbolic beadwork, the tools and other articles are all indicative of contact with the Europeans. The False Face Ceremony is one of the most spectacular rites common among the Iroquois. The figures are all life casts of Cayuga Indians and the view through the open doorway is of a moonlight winter's night on the frozen Cayuga Lake.

Typical Iroquois Industries.—This group depicts a company of Oneida Indians gathered in a sheltered spot in the woods near their capitol village on Nichols Pond, Township of Fenner, Madison County. This was the fort unsuccessfully stormed by Champlain in 1615. The arrowmaker in the center is telling an amusing tale while he chips his flints. About him are the basket maker and belt weaver, the wood carver, the moccasin maker and the potter, all engaged at their occupations as they

listen to the arrowmaker's story. The figures are casts of Oneida Indians.

The Corn Harvest.—This group depicts a harvest scene in the maize fields on the flats near Squakie Hill in the Genesee Valley looking south toward the High Banks of the Genesee River. With one exception the figures are all of women who are engaged in harvesting, braiding and pounding the maize and baking corn bread. The autumnal coloring is brilliant and the background very rich and effective. The figures are life casts of Seneca Indians.

SCIENTIFIC NOTES AND NEWS

The degree of doctor of laws has been conferred by Washington University on Dr. Theobald Smith, of the Rockefeller Institute for Medical Research.

At the commencement exercises celebrating the fiftieth anniversary of the founding of Lehigh University the degree of doctor of science was conferred on Joseph Barrell, B.S. ('92), professor of structural geology in Yale University.

The Paris Academy of Sciences has elected, as corresponding member in the section of medicine, Dr. Yersin, of Nha-Trang (Annam), former worker at the Pasteur Institute, known for his work in bacteriology, especially on antiplague serum.

The *Journal* of the American Medical Association states that ever since Professor Kitasato resigned his office as director of the Imperial Institute for the Study of Infectious Diseases, in consequence of the amendment of the imperial ordinance which took place quite against his and his followers' wishes, public sympathy has been aroused to help him in completing his new enterprise in establishing an institute, which was completed in December last. His services have been recognized by over 400 statesmen, business men and others of his native province, Kumamoto, who held a meeting on April 10, at which they presented him with a medal in order to express their recognition of his achievements in promoting bacteriology, public health and medicine.

We learn from the *Journal of Engineering and Industrial Chemistry* that Professor E. C. Franklin, of the Leland Stanford University, has had an unfortunate laboratory accident, through an explosion in his laboratory which caused burns and other injuries. Later news announces that he is recovering in the hospital and that the accident will not leave serious consequences.

Mr. Clyde H. Bailey, cereal technologist of the Minnesota Agricultural Experiment Station, has been granted a year's leave of absence to take up research work in the laboratory of the State Grain Inspection Department in Minneapolis.

Professor George M. Reed, of the department of botany of the University of Missouri, has been appointed research fellow at the Brooklyn Botanic Garden for the summers of 1916 and 1917, in place of Professor W. H. Rankin, of Cornell University, who was obliged to resign on account of a change in his duties at Cornell. The problem to be investigated is the diseases of the trees and shrubs of Prospect Park, which adjoins the Botanic Garden.

Dr. Martin B. Tinker, who was professor of surgery at the Cornell Medical College in Ithaca from 1903 till the second-year instruction was discontinued at Ithaca, has been elected to the presidency of the New York State Medical Society.

A cablegram has been received by the Museum of the University of Pennsylvania officials from Dr. William C. Farabee, leader of the university museum's Amazon Expedition, saying that he has sailed from Para, Brazil, and expects to reach Philadelphia about the middle of this month. Dr. Farabee is bringing the collections he has made in the last two years, those of his first year having reached the museum.

Professor Adolph F. Meyer, consulting engineer to the International Joint Commission, has just returned from the northern part of the state of Minnesota where he was called to investigate flood conditions prevailing on the Lake of the Woods watershed. Damage

from high water has been serious and widespread and the waters are still rising. Professor Meyer stated that if such regulation of these waters as the International Joint Commission will soon recommend to the government of the United States and Canada had been in force, most, if not all, of the damage could have been prevented.

A SECOND relief expedition is to be sent out from the American Museum of Natural History and the American Geographical Society in the hope of rescuing Donald B. MacMillan and the members of the Crocker Land Expedition sent out in 1913 by the American Museum of Natural History, the American Geographical Society and the University of Illinois. The party is believed to be several hundred miles northwest of northern Greenland. The first relief expedition is frozen in at Parker Snow Bay, 150 miles south of Etah. The second expedition will try to join forces with the first and then proceed to Etah. The steamship *Danmark* has been chartered for the trip, and the sum of $11,000 has already been pledged—$6,000 by the American Museum and its friends and $5,000 by the American Geographical Society. According to George H. Sherwood, assistant secretary of the museum, the members of the expeditions are in a serious plight, and there is urgent need of more funds to finance the new relief expedition.

A DESPATCH from Montevideo, dated June 6, states that a relief expedition for the rescue of the twenty-two members of Lieut. Sir Ernest Shackleton's Antarctic expedition left behind on Elephant Island will start immediately.

THE Bureau of American Ethnology of the Smithsonian Institution is manifesting considerable activity in archeological and ethnological research in the field at the present time. Mr. Neil M. Judd and Dr. Walter Hough have been temporarily detailed by the National Museum for the purpose of conducting archeological investigations in southern Utah and western New Mexico, respectively, and Dr. J. Walter Fewkes is engaged in work of a similar nature northeast of the Hopi villages in northern Arizona. Mr. John P. Harrington is devoting his attention to gathering the final material necessary to the completion of an exhaustive memoir on the practically extinct Chumash Indians of southern California; Mr. J. N. B. Hewitt is among the Iroquois of Ontario; Dr. Truman Michelson has resumed his studies among the Fox Indians of Iowa, and Mr. James Mooney has taken the field for the purpose of continuing his studies among the Cherokee of North Carolina. Mr. Francis LaFlesche has recently returned from a trip to the Osage tribe of Oklahoma after recording additional material pertaining to the sacred ceremonies of that people. Miss Frances Densmore will shortly resume her studies of Indian music in the field, special attention this summer being devoted to the Hidatsa Indians of North Dakota, while Dr. L. J. Frachtenberg is still engaged in studying the almost extinct Indian languages of Oregon.

AT a meeting of the Washington Academy of Sciences, on May 11, Dr. Erwin F. Smith, of the Bureau of Plant Industry, delivered an address on "Resemblances between Crown Gall in Plants and Human Cancer." This address will be printed in SCIENCE.

PROFESSOR ARTHUR B. LAMB, of Harvard University, lectured on "Induced Reactions," in the Havemeyer Chemical Laboratory, New York University, on May 12.

THE Halley Lecture at the University of Oxford was delivered on May 20, by Dr. G. W. Walker, late fellow of Trinity College, Cambridge. His subject was "The Measurement of Earthquakes."

DR. CHARLES B. ALEXANDER, of New York, a regent of the University of the State of New York, gave a dinner in Albany last week in honor of Dr. John J. Carty, president of the National Institute of Electrical Engineers, and Professor Michael Pupin, Serbia's Consul to this country and professor in Columbia University. The guests inspected the instruments contrived and used by Professor Joseph Henry while a teacher in the Albany Academy in making the first successful experiments on long-distance electric transmission beginning in 1827. Professor Pupin pledged himself to raise $15,000 if a like sum were raised to erect

a bronze statue of Professor Henry in the park in front of the school in one of whose rooms the great discovery was made. Dr. John J. Carty and Regents Pliny T. Sexton, Charles B. Alexander, Chester S. Lord, Abram I. Elkus, James J. Byrne, Adelbert Moot, William Berri and Albert Vanderveer each pledged $100.

Professor Karl Schwarzschild, director of the Astrophysical Observatory at Potsdam, has died from illness contracted while on military service.

The death is announced of Mr. John Griffiths, formerly tutor in mathematics and for many years past senior fellow of Jesus College, Oxford.

An appeal has been issued by the Chinese Medical Board to the medical profession of Philadelphia to supply fifty physicians and surgeons for immediate service at hospitals in China. It is believed that the furnishing of this unit will be undertaken by the College of Physicians of Philadelphia.

Invitations from the Kansas City Section of the American Chemical Society and from the University of Kansas to hold the spring meeting of 1917 in Kansas City, Mo., and in Lawrence, Kan., have been accepted.

A meeting for the reading of papers will be held by the Ecological Society of America at San Diego, in connection with the meeting of the Pacific Division of the American Association on August 9, 10 and 11. Two field excursions in the vicinity of San Diego will be held by the society on the succeeding days.

At the tenth annual meeting of the British Science Guild, held on May 17, the Right Hon. Andrew Fisher, high commissioner for the commonwealth of Australia, described the establishment of the National Institute of Science and Industry in Australia. Surgeon-General Sir Alfred Keogh, referring to the relation of science to the work of the Royal Army Medical Corps, said that in the British army in France there were twenty-two cases of typhoid fever and stated that under former conditions there would probably have been from eighty to a hundred thousand cases. Dr. R. Mullineux Walmsley, principal of Northampton Polytechnic Institute, E.C., spoke of the work of the technical optics committee of the guild.

On the occasion of his seventieth birthday on March 16, 1916, Professor G. Mittag-Leffler and his wife made a joint last will and testament of peculiar significance in the domain of science. Extracts from this will have recently been published by Professor Mittag-Leffler in a pamphlet, so that the features of the document are now public property. By the terms of the will there is founded a mathematical institute to bear the name of the donors, which institute is to be housed in their villa at Djursholm, Stockholm. The institute is to be fully established at the death of the donors, and is to consist of the villa in question, the mathematical library of Professor Mittag-Leffler, and a fund for the encouragement of pure mathematics, particularly in the four Scandinavian countries, Sweden, Denmark, Finland and Norway, but more especially in Sweden. The library is to be open to all mathematicians, subject to the approval of the president of the committee of trustees, or the director of the institute. Certain financial assistance is to be given to those who show genuine aptitude for research and discovery in the domain of pure mathematics. There is also provided for the bestowal of medals and of prizes in the form of sets of the *Acta Mathematica*. The institute thus becomes one of the most noteworthy establishments in the learned world, and will be a perpetual monument to the great interest in mathematics always manifested by Professor Mittag-Leffler.

The *Journal* of the American Medical Association states that the seventeenth annual meeting of the Kitasato Institute Alumni Association was held on April 3 and 4, and at the general meeting held on the afternoon of the second day the discoverer of the cause of infectious jaundice, Professor Inada, and his assistant, Dr. Ido, were awarded by Professor Kitasato the prize of the late Professor Asakawa fund. The prize consisted of a gold medal and a sum of money. It is offered for the best

work on bacteriology, parasitology, immunology and study of infectious diseases carried out and published in Japan during the preceding year. The work consisted of the discovery of the cause of the infectious jaundice, which prevails endemically not only in Japan but also in other countries. The causative agent has been discovered to be one of the species of spirochetes.

IN accordance with plans approved by Secretary of the Interior Lane, the investigation of the mineral resources of Alaska by the Geological Survey will be continued this year by 12 parties. Congress has recognized the necessity of preparing in advance for the survey of this difficult field by including the appropriation for its continuation in the urgent deficiency act, which was approved on February 28. This prompt action makes it possible to plan the work in advance of the opening of the field season and to carry out the plans efficiently and economically. The work to be done this year includes a detailed survey of the region tributary to Juneau, Juneau, which is the most important quartz camp in Alaska. A continuation of the study of the mineral resources of the Ketchikan district, where there are important gold and copper mines, is also planned. The investigation of the water powers of southeastern Alaska will also be continued. Only one party will be employed in the Copper River region. Two parties will work in Prince William Sound. Four parties will make surveys in the region directly or indirectly tributary to the government railroad under construction. One of them will study the new Tolovana placer district and also make some supplementary investigation of the Fairbanks lode district. The geologists of this party will later visit the Nome district. A detailed geologic survey will be made of the western part of the Nenana coal field, which is adjacent to the route of the government railroad. Two other parties will be employed in carrying reconnaissance surveys westward from the railroad route to the Kantishna placer and lode district. It is also proposed to make surveys of the lower Yukon, including the Marshall placer district.

IT is stated in *Nature* that at the recent annual meeting of the Paris Academy of Sciences, the president, M. Gaston Darboux, gave an account of the careers of men, for the most part young, to whom prizes of the academy had been awarded, but who have fallen in the service of their country. M. Marty (Francœur prize), killed September 10, 1914, at the battle of the Meuse, was distinguished by his contributions to mathematics. M. R. Marcelin (Hughes prize), killed near Verdun, in September, 1914. His work on kinetic physical chemistry was remarkable, both in theoretical treatment and on the experimental side. M. Marcel Moulin (Gaston planté prize), killed at the battle of the Marne, September 6, 1914, founded the Institute of Chronometry at Besançon. M. Viguier (Cahours prize), killed at Beauséjour, March 5, 1915, made his mark in the field of organic chemistry. M. Albert de Romeu (Delesse prize), killed January 12, 1915, at Bucy-le-Long, near the Aisne, was the author of noteworthy petrographic work. M. René Tronquoy (Joseph Labbé prize), wounded and missing, February 20, 1915, was proposed for the Cross of the Légion d'honneur, and was well known for his mineralogical work. M. Blondel (Saintour prize), wounded and missing, September 8, 1914, at Fère-Champenoise, was distinguished for his work on the theory of tides. M. Georges Lery (Gustave Roux prize), killed at the battle of the Marne, September 10, 1914, was a geometer of great promise. Lieutenant-Colonel Arnaud (Henri Becquerel prize), aged sixty years, died of illness contracted on active service. M. Jean Merlin (Becquerel prize), on the staff of Lyons Observatory, killed at Arrozel, August 29, 1914. He was known by his researches dealing with the theory of numbers. M. Rabioulle (Becquerel prize), on the staff of the Algiers Observatory, killed in the battle of the Aisne, September 21, 1914. M. Jean Chatinay (Fanny Emden prize), killed at Vermelles, October 15, 1914. Commandant Henri Batail-

ler (Wilde prize), killed June 9, 1915, well known for his researches in ballistics.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Dr. J. William White, trustee of the University of Pennsylvania, and John Rhea Barton emeritus professor of surgery, $150,000 is bequeathed in trust as a permanent endowment fund, the income to be used for establishing a professorship of surgical research in the medical department of the university. Other bequests were made to the university hospital.

A million dollars will be available for use by the Washington University Medical School, with the opening of the new term in September, through the donation to the school of $166,000 each by Edward Mallinckrodt and John T. Milliken, of St. Louis. One fund of $500,000, which will be known as the Edward Mallinckrodt Fund, will be devoted to teaching and research work in pediatrics. The other fund of $500,000, which will be known as the John T. Milliken Fund, will be devoted to teaching and research work in medicine. The funds will enable the medical school to employ physicians in these departments for their full time. The amount in addition to the Mallinckrodt and Milliken donations to bring it to $1,000,000 has been given by the General Education Board.

A movement has been inaugurated to secure at least $2,000,000 additional endowment for Jefferson Medical College, Philadelphia. Mr. David Baugh, a member of the board of trustees, and founder of the Baugh Institute of Anatomy and Biology, has subscribed $100,000, provided that an equal amount is raised on or before June 16. The money so obtained is to be used for permanent endowment.

The executors of the estate of Emil C. Bundy, of New York, have paid over to Columbia University the sum of $100,000, for research work in cancer.

Dr. Jean Piccard, of the University of Lausanne, Switzerland, has been appointed assistant professor of chemistry in the University of Chicago, beginning with the autumn quarter of this year. Professor Piccard is of the same nationality as the late Professor John Ulric Nef, who for more than twenty years was the distinguished head of the department of chemistry.

Dr. Henry W. Wandless, of New York, has been appointed clinical professor of ophthalmology at the University and Bellevue Hospital Medical College.

Wm. F. Allen, formerly instructor of histology and embryology in the University of Minnesota, has accepted the position of professor of anatomy in the University of Oregon Medical School, Portland, Oregon.

At Vassar College Dr. Elizabeth B. Cowley, assistant professor of mathematics, has been promoted to an associate professorship.

Sir James Alfred Ewing, K.C.B., F.R.S., has been elected principal of the University of Edinburgh, in succession to the late Sir William Turner. Sir Alfred Ewing, who is a graduate of the university, has been for the last thirteen years director of naval education; before that he had been in succession professor of mechanical engineering in the Imperial University, Tokyo; of engineering in University College, Dundee, and of applied mechanics in the University of Cambridge. His scientific work has been chiefly in the investigation of magnetism and the physics of metals.

DISCUSSION AND CORRESPONDENCE

PUBLIC HEALTH WORK AND MEDICAL PRACTISE

To the Editor of Science: To the statement that no sharp line can properly be drawn between preventive medicine as embraced in public health work and curative medicine as applied to individuals Mr. Harold F. Gray in Science for May 5 has applied the term "fallacious." While it may in general be true that "under our form of government, it is not possible for public health officers to apply by compulsion remedies to diseased citizens," it is also true that in a democracy a large share of public health work lies outside the field of arbitrary compulsion.

Quarantine of individuals afflicted with communicable disease represents one of the earliest and most arbitrary of public health measures. The stoning of a leper to keep him away from a community without regard to the welfare of the leper himself is not, however, to be regarded as a sign of a high stage of civilization. We reach a higher stage when special provision is made for the care of lepers isolated from the community for the good of the community. We reach a still higher stage when earnest efforts are made to discover remedies for the cure of the disease such as are now being made by the federal health service. If such remedies are discovered and applied, both lepers and the community at large will profit.

The legal aspects of the matter are well summarized in a decision of the Wisconsin Supreme Court as cited in "Communicable Diseases: An analysis of the laws and regulations for the control thereof in force in the United States," Public Health Bulletin No. 62, by J. W. Kerr and A. A. Moll.

> The right of a state through its proper officers to place in confinement and to subject to regular medical treatment, those who are suffering from some contagious or infectious disease, on account of the danger to which the public would be exposed if they were permitted to go at large is so free from doubt that it has rarely been questioned (State *v.* Berg Northwestern Reporter, p. 347).

The federal public health service has charge of the restrictions imposed upon individuals afflicted with disease who desire to enter the United States from outside and is required to cooperate with local health authorities in enforcing regulations to prevent the spread of contagious and infectious diseases from one state or territory to another.

> In connection with the medical inspections of immigrants, medical officers are required, among other things, to certify to the diseases observed by them and to render opinions, whenever requested, as to the curability of a loathsome contagious or dangerous contagious disease affecting the wife or minor child of a domiciled alien, and to supervise the appropriate treatment. In addition they are required to supervise or conduct the treatment of all detained aliens.

In the various states of the union the number of diseases for which quarantine is required by law and the extent of the quarantine differ greatly but it is fairly generally recognized that in cases where strict quarantine is required the public is under obligations to furnish treatment at least to individuals not able to pay for medical service. The quarantine is compulsory, the treatment is not necessarily so, but both may properly form a part of the public health service. At times special care has been taken to emphasize the fact that individuals thus receiving medical service at public expense are not thereby made paupers.

Private agencies may cooperate with public health officials in the warfare on disease through treatment of individuals. The various anti-tuberculosis associations are accomplishing much in their efforts not only to educate the public as to proper precautions to be taken to prevent the spread of this disease but also in their support of measures for the establishment of sanatoria for the treatment of incipient cases and homes for the isolation of advanced cases. The effective work of the Rockefeller Sanitary Commission in cooperation with various boards of health in the south for the eradication of hookworm disease is an example of where medical treatment of individuals in the ordinary use of that term has played an active part in public health work.

Various steps have been taken to give state aid to physicians in their treatment of individuals in order that the public health may be promoted. Examples are to be seen in the distribution of diphtheria antitoxin free either for all cases or more frequently for all indigent cases. Vaccines for smallpox and typhoid fever are distributed in a similar way for the prophylactic treatment of individuals, from which in turn the community profits. Public health laboratories established to give aid in diagnosis to physicians in private practise are becoming of increasing importance from the standpoint of public health. It is thus that the first steps are being taken in control of venereal diseases.

In public health work we have, on the one hand, engineering problems into which dis-

eased individuals as such do not enter. On the other hand we have the problem of the prevention of the spread of diseases from the sick to the well. In private practise we have, on the one hand, the treatment of sick individuals in whose welfare the public as such, aside from humane sympathy or the danger of attendant financial burdens, has no concern and, on the other hand, the treatment of individuals who so long as they are ill are of more or less danger to the community at large. The fields of the sanitarian in the prevention of the spread of disease from one individual to another and of the private practitioner in his care of individuals afflicted with communicable disease interweave. The duty of the public health officer is to see that such persons are cared for in a way that prevents so far as possible the spread of disease. The private practitioner attending such individuals is required to observe regulations in the interest of the public health. Questions of public interest should determine to what extent treatment of individuals by private practitioners should be supplemented by state officers. There certainly need be no fear that medical treatment furnished sane adult individuals for their own welfare by public officials will be forced on them at the expense of their individual liberty. In medical supervision in the public schools it has not yet been determined to what extent medical inspection of the school children should be supplemented by furnishing medical treatment at public expense, but such treatment is likely to increase in the future. In the assumption by the public of responsibility for the health of children as individuals, a responsibility that is beginning to extend back of the school years, public health duties are assumed which reach far beyond the control of contagious diseases and are of great importance to the welfare of the race. Perhaps some time we shall see in times of peace as effective a medical service as nations which desire success must have for their armies in times of war. Here we see no line drawn between services for preventive medicine and curative medicine. Fortunately our own army medical service has been able to furnish some of the most important recent advances in preventive medicine, of value alike in times of peace and times of war, an interesting summary of which has recently been given by Henry B. Hemenway.[1] It is noteworthy that the most important American contributions both to the science of public health and to the application of this science have been made by medical services which include within their scope research, prevention and treatment, the Army Medical Service and the Federal Public Health Service.

C. R. Bardeen

NOMENCLATORIAL CONSISTENCY?

Nothing more strikingly illustrates the hopelessness of unanimity among systematists on nomenclatorial matters than a footnote in a recent article by Mr. Hebard, *Ent. News*, Vol. XXVII., p. 17 (1916). Here he protests strenuously against the resurrection of the orthopterous genus *Pedeticum* of McNeill, which he maintains is preoccupied by the hemipterous genus *Pedeticus* of Laporte. But these two names do not conflict according to the apparent meaning of Article 36 of the International Rules of Zoological Nomenclature, where it is recommended that names even derived from the same radical and differing from each other only in termination are not to be considered as conflicting. Furthermore, opinion 25 of the International Commission bears directly on this subject, quotes from the above mentioned recommendations and decides that *Damesella* does not conflict with *Damesiella*. Dr. C. W. Stiles, the secretary of the International Committee on Zoological Nomenclature, and our foremost authority on nomenclature, when consulted regarding the matter of *Pedeticum* and *Pedeticus*, expressed the opinion that these two names should not be considered as conflicting. But Mr. Hebard contends that the ornithologists and mammalogists have long ago settled this matter, the one-letter rule being suppressed unless indicating different word derivation. This being true, how about those, including Mr. Hebard himself, who profess themselves followers of the International Rules? Is it to be assumed

[1] "American Health Protection," Bobbs-Merrill Company, 1916.

that they follow these rules as such rules are usually followed, that is only so far as they conflict with no personal opinion?

In the above-mentioned note Mr. Hebard expresses regret that well-known names should be changed on debatable grounds. In view of this statement it is interesting to note his use in the same paper, page 19, of the name *Schistocerca serials* Thunberg instead of *Schistocerca americana* Drury, a name in common use long before *Pedeticum* was erected. That the original inclusion of the species *americana* in the genus *Libellula,* which makes it a primary homonym of *Libellula americana* Linn., a true dragon fly, was a *lapsus* seems clear for several reasons, a matter too complicated for discussion at this time. However, even if granted as obviously a *lapsus calami,* there appears to be no definite authority in any code of rules for the setting aside of this reference. Thus Mr. Hebard's suppression of the name *americana* is accepted, but, until a decision is rendered on the case by the International Commission, the grounds upon which he suppresses it are certainly debatable, more so, in fact, than those upon which the present writer resurrects the genus *Pedeticum.* Indeed this action of Mr. Hebard would probably not be sustained by the International Commission if it acts on the case, as its decision would very likely agree with the private opinion of its secretary, Dr. C. W. Stiles, as stated in the authorized quotation here given from a letter written on April 10, 1916:

> . . . In the case of *Libellula americanus* Drury, 1770 (in index of later date) it seems clear that this is a *Lapsus calami.*
>
> Without attempting to commit the Commission to any view, I personally would not reject—especially at the present moment—a well-known name like *Gryllus americanus* seu *Schistocerca americana* because of an obvious *lapsus calami.*

Dr. L. Stejneger, also a member of the Commission on Zoological Nomenclature, authorizes the statement that his present views on this matter coincide with those expressed in the above quotation.

A. N. CAUDELL

BUREAU OF ENTOMOLOGY,
WASHINGTON, D. C.

THE CURRENT "DEFINITIONS" OF ENERGY

TO THE EDITOR OF SCIENCE: In a communication which appeared in a recent number of SCIENCE[1] Professor M. M. Garver criticizes the current definitions of energy, such as "the capacity for doing work," the "ability to do work," and the "power of doing work," on the ground that these definitions are not consistent with the concept of energy. The terms "capacity" and "ability" do not mean entities, while energy is not only a physical entity but it has the property of conservation.

It seems to me that Professor Garver's criticism is well taken, but the alternative he proposes is open to criticism also. For Professor Garver would have no definition of energy at all or, if it is insisted upon, he would have it based on the principle of the conservation of energy.

Energy is first introduced in text-books of physics as a mechanical concept. Therefore any definition of energy should form an integral part of a logically developed system of mechanics. It should be the direct and natural result of the dynamical concepts which precede it and should form an adequate basis for the new ideas which follow it. Further it should have such a form as to lend itself easily to a mathematical expression of the definition. Elementary mechanics is usually based upon postulates, such as Newton's laws of motion or the action principle, which involve the concept of force. Therefore the definitions of energy and momentum as well as the principles of the conservation of energy and of momentum should be made the direct consequence of the postulates which have been selected as the starting point of the development of mechanics. This necessitates the definition of energy as the "result of the action of force in space" and the definition of momentum as the "result of the action of force in time." In other words, energy should be defined in terms of work and momentum in terms of impulse. The definition of energy contained in the following extract fulfills these conditions. It is not only consistent, but has the advantage of leading to the mathematical expressions for kinetic and potential energy.

[1] SCIENCE, April 21, 1916.

Energy may be defined as work which is stored up. Work stored up in overcoming kinetic reactions is called kinetic energy. Work stored up in overcoming non-frictional forces, such as gravitational forces, is called potential energy. Work done in overcoming frictional forces is called heat energy.

Potential, kinetic and heat energy are different (at least apparently[2]) forms of the same physical entity, *i. e.*, energy. Energy may be changed from any one of these forms into any other form. Whenever such a change takes place energy is said to be transformed. Transformation of energy is always accompanied by work. In fact the process of doing work is that of transformation of energy. The amount of energy transformed equals the amount of work done.[3]

Yale University

UNITS OF FORCE

To the Editor of Science: I have read with much interest Professor Kent's article in Science on the units of force. I might say that I have taught mechanics in my physics course this year, using the units the way Professor Kent recommends. The results have been entirely successful and highly gratifying. I used the pound and the gram as the units of mass and the pound and the gram as the units of force. As far as the results to the student go it has resulted in conciseness and clearness of thought and an avoidance of the unescapable confusion that results from introducing units that nobody but a teacher of physics wishes to use. Not only did this apply to force equations but it had a good result all along the line in problems on work energy and power. I embodied in my method of teaching the things that Professor Kent recommends and also many of the things that Professor Huntington recommends. I believe that a great deal of the trouble is due to the fact that most of our teachers of physics do not have the point of view of the engineer (they should have if they teach engineers) and I believe that the only way to get this point of view is in the school of practical engineering. This hodgepodge of units which some of us wish to use are undesirable and pedagogically unsound.

Paul Cloke

[2] Recent developments in physical sciences tend to show that differences between different forms of energy are only apparent and that all forms of energy are, in the last analysis, kinetic.

[3] H. M. Dadourian, "Analytical Mechanics," 2d edition, p. 248. H. M. Dadourian

THERMOMETER SCALES

To the Editor of Science: In a letter published in Science of May 5, 1916, page 642, a correspondent advocating the retention of the Fahrenheit scale says that "nine tenths, probably, of the use of the thermometer is for the weather" a statement that should not pass unchallenged; but even if there were no other uses of the thermometer, the Fahrenheit scale would still be objectionable. If your correspondent will visit any extensive meteorological library, he will find that nearly all national weather services now use the Centigrade scale and that internationally no other scale has been recognized for some years. Even the few weather services retaining the Fahrenheit scale, restrict its use and banish it from all investigational and research work.

It is urged that "the common people are familiar with the Fahrenheit scale." They may be familiar with it and yet not understand it. When the temperature is 64° F., is it clearly understood by every one, that the temperature is 32 degrees above freezing; and on the other hand when it is —32° F., that the temperature is 64 degrees below freezing? The scale says one thing and means another. It is true that the Centigrade scale division is nearly twice the length of the other scale division; and much has been made of this by some who insist upon accuracy to the tenth of a degree; but it may be well to remember that most air temperatures are a degree or more in error. Even with official instruments, errors of exposure or time, exceeding several degrees, go uncorrected, while instrumental errors are applied to a tenth of a degree. On the daily weather map one finds isotherms charted from readings made at different hours and different elevations. A reading made at 5 A.M. in the Nevada desert is linked up with readings made at 8 A.M. on the Atlantic seaboard. Some years ago, I suggested to the

former chief of the Weather Bureau that the hour of observation be given at the top of the map; and the suggestion was adopted; but the type used is small and at best this is only a makeshift. If the isotherms are to have true comparative value, diurnal corrections should be applied, whatever scale be used to express values.

At Blue Hill Observatory, no less than three scales have been used and we are now considering a fourth. Beginning with 1891, the Centigrade scale displaced Fahrenheit in our published summaries. In 1914 the Absolute scale displaced the Centigrade, the first of the three figures being written once in tabular work at the head of the column. The use of minus signs for low temperatures, frequent in winter months for surface readings, and in all months with upper air readings, is thus avoided.

The objection made, however, to the length of the Centigrade division holds also for the Absolute scale and therefore the writer suggested[1] a scale based on the Absolute system but with the present 273° marked 1,000°.

For many reasons the freezing point is important. The new scale emphasizes this point. The boiling point is not so definitely marked but the whole system has the advantage of flexibility and consistency. For thermodynamic problems it is an ideal arrangement.

ALEXANDER MCADIE

SCIENTIFIC BOOKS

American Civilization and the Negro. By C. V. ROMAN, A.M., M.D., LL.D., Editor of the Journal of the National Medical Association, etc. Philadelphia, F. A. Davis Co., 1916.

This book is obviously prepared and published as an antidote for Shufeldt's book on the negro, issued last year by the same firm.[1] As such, it is a complete and amusing success. The word "amusing" is used advisedly, for Dr. Roman has by imitation without comment emphasized many of the weaknesses and defects of Dr. Shufeldt's book. Moreover like most of his race, Dr. Roman has a keen sense of humor and real skill in the use of witty phrases, so that many of his aphorisms are exceedingly clever. From the title-page, with its long list of degrees, honors and positions, following the author's name, to the very full glossary at the end of the book, Roman has taken his cue from Shufeldt, with such good-natured appreciation of the Caucasian author's failings that any one who has read both books can not help but be amused. In no respect is this done better than in the matter of illustrations. In neither volume is there any particular connection between text and plates, but whereas Shufeldt's figures are deliberately chosen to exaggerate the animal nature of the negro and make him repulsive to the reader, Roman's illustrations are selected to exaggerate his intellectual and spiritual achievements and make him most attractive.

Neither volume is in any real sense a scientific book, but whereas Shufeldt's pretends to be, Roman's makes no such claim. The latter author says truly in his Preface: "This book is written without bitterness and without bias" and in the hope that it "may increase racial self-respect and diminish racial antagonism." The good nature and self-control of the author are notable and his evident familiarity with the literature of the subject is equally so. There are very few references to Shufeldt, Bean or other negrophobists, but many quotations from Boaz, Murphy and Cable, real and sympathetic students of the race problem. The chief contention of the author is that there is no superior *race,* but that there are superior *individuals,* and that the effort of all races should be to increase the number of these superior individuals of whatever race, while weeding out the inferior. He admits frankly that at the present time, the whites average higher than the negroes but he very properly claims that there is far less difference between the best whites and the best negroes than there is between the better and worse elements of either race. His chief protest is against the utterly unfair and unscientific method of treating all colored people alike because they are colored, and he emphasizes the

[1] *Physical Review,* N. S., Vol. VI., No. 6, Dec., 1915.

[1] See SCIENCE, N. S., Vol. 42, p. 768.

importance of encouraging the development of the exceptional individual in every race.

The fifteen chapters which make up the volume are of rather unequal merit and seem to have no natural sequence. This defect of arrangement is emphasized by faults of style. The writer is discursive and tends to glowing rhetoric, "glittering generalities" and overmuch interpolation of poetry and emotional anecdote. There is too much repetition and iteration, oftentimes on trivial points. In spite of all this, the book is readable and enjoyable because of the author's skill in putting telling points in brief, pithy sentences. In discussing physiognomy as a criterion for judging men, he says: "As a man *thinks,* not as he *looks,* finally fixes his status," and again, referring to facial angles and jaw form, "Thoughts and not bites win the battles of life." In reference to the origin of the southern negroes, we find these apt words: "The question then is, not where did he start from, nor how long has he been on the road, but *has he arrived?*" In chapter ten, "The Solution," probably the best chapter in the book, there is an admirable plea for the suppression of those people who, and things which, tend to encourage racial friction. The following deserves quotation. "Dixon and Johnson have been drawbacks to their race and country. It was an unfortunate thing for the country that popular notice was given to the Leopard Spots or the Reno Battle. If neither had been noticed the subsequent 'bad eminence' of the chief actors would not have marred the country's history."

The frankness and fairmindedness of Dr. Roman are constantly in evidence. His appreciation of the point of view of the best southern whites is delightful and most encouraging. Referring to their claim of "the absolute and unchangeable superiority of the white race" he says: "Fundamentally erroneous and mischievous as I believe this assumption to be, I am not disposed to quarrel over it with such men as Messrs. Page and Murphy." "From different starting points, Mr. Page and I reach the same conclusion: 'Our plain duty is to do the best we can to act with justice and a broad charity and leave the consequences to God.'" One other quotation is necessary to reveal the point of view of the best southern colored men on that bugbear "social equality." Dr. Roman says: "I know my people, their hopes, their fears, their aspirations and their desires; and from my youth up I have preferred a discreet silence to false or dishonorable speech. With all candor and earnestness I say to the American public: *the negro has no desire to break over social barriers. In this regard he is if possible more strongly prepossessed in favor of his own than the white man.* In these matters the negro is not only pleased but happy to work out *his own equivalent rights.* But in civil, political and economical matters the negro insists and for the good of the country ought to insist upon *equal,* not *equivalent,* rights." If this is not a scientifically impregnable position, your reviewer fails to detect its weakness. It seems to him obvious that the one possible solution of the race question lies in strengthening racial self-respect and mutual interracial confidence. For this reason, all legislation looking towards segregation of either race is sadly mistaken and postpones indefinitely the solution intelligent men on both sides are seeking. As Dr. Roman truly says: "White ignorance is the most serious menace in the race situation; for this ignorance is in power and hopes to benefit itself not by finding more light but by increasing darkness." Colored ignorance is much less mischievous because so much less powerful, but it is of course a serious menace. Racial self-respect should be greatly promoted among the negroes by the publication of Dr. Roman's book, and racial comity should be likewise advanced. For there is as much for the white race in the volume as there is for the author's own people.

Hubert Lyman Clark

The Elements of Surveying and Geodesy. By W. C. Popplewell. Longmans, Green and Co., London, 1915. Pp. ix + 244, illustrated.

The author states in the preface of this volume that he has made an attempt to present a comprehensive view of the subject of geodesy in its widest sense in order to provide students and others with such information as may lead

to a sound knowledge of the fundamental ideas involved. As leading towards this the author said he has always advocated personal instruction in the use and adjustment of instruments, as well as the useful practise which may be obtained in a students' surveying camp, but that before either of these is possible the student must have mastered the bedrock principles, and the author hopes that a careful perusal of the pages of the volume may help him to do this.

The book is disappointing and is not recommended to the student of engineering nor to the practising engineer as a guide or manual. It seems to be more suited to the old-fashioned county surveyor, with his Jacob's staff and Gunter's chain, for the county surveyor of today, in the United States at least, is more inclined to use the steel tape and the transit than those old instruments, which should be relegated to the museum.

The chapter on "Calculations of Distances and Heights" opens with the statement that "It is assumed that the reader has some knowledge of plane trigonometry." In this country there is probably no school teaching surveying which does not require a rather thorough course in plane trigonometry as a preliminary to the course in surveying.

Under the heading, "Levelling and Contouring" this significant statement is made: "The staff-holder should be very careful to see that the particular spot of ground upon which the staff rests is fairly flat, and if the ground is of a soft or spongy nature the spot should be pressed down with the foot." This is not teaching correct principles, for there is scarcely any leveling which should not require solid supports for the rod, and the earth, even if "*pressed down by the foot,*" can not be considered a satisfactory rod support.

The short chapter on "Geodetic or Trigonometrical Surveying" is almost entirely historical and gives the student nothing which would guide him in actual work. Even the historical part does not include the recent developments and methods.

The chapter on "Geodetic Astronomy" is particularly disappointing, for it deals with only those methods which might be used in explorations and in determining the variation of the compass.

It is very difficult to see where or how such a book has any useful purpose, for there are so many other books available which are far better for both the student and the engineer.

WILLIAM BOWIE

Diabetes Mellitus. By NELLIS B. FOSTER, M.D. J. B. Lippincott and Company, 1915.

This is a model monograph for the modern practising physician. Clearly written and not too technical in language, it is still thoroughly scientific in the mode of presentation. The rapid advance in the knowledge of the fundamental biochemical processes which take place within the living body has nowhere been more pronounced than in studies concerning the nature of diabetes, a disease in which the oxidation of glucose, a substance which ordinarily furnishes two thirds of all the chemical transformations of the organism, has been impaired or totally abolished. Dr. Foster has presented all the essential details concerning the pathological chemistry of diabetes, and has at the same time written from that three-fold standpoint which controls the value of a modern medical book, personal research, personal clinical experience, knowledge of the research and clinical experience of the best authorities of the modern world. In no other book on diabetes has the value of American work been so fully recognized, and the reviewer feels that it is the best book upon the subject which has been written.

GRAHAM LUSK

SPECIAL ARTICLES

PERMEABILITY AND VISCOSITY

IN a recent article[1] Spaeth has suggested that the permeability of the surface layer of protoplasm is determined by its viscosity, which in turn depends on its colloidal condition. Increased permeability may be produced by increased colloidal dispersion, which decreases viscosity and permits substances to diffuse more rapidly into the protoplasm. An

[1] SCIENCE, N. S., 43: 502, 1916.

increase of colloidal aggregation increases viscosity and causes a decrease of permeability: but if this goes beyond a certain point it produces "a decrease in the degree of intimacy between disperse phases and solvent; the fluidity is suddenly increased and diffusion across the surface is correspondingly facilitated."

Some years ago a similar conception was suggested to the writer by the fact that living tissue of *Laminaria* placed in NaCl[2] becomes much softer while in $CaCl_2$ it becomes much harder. The changes in viscosity are so great as to suggest that they are fully capable of explaining the fall of the electrical resistance of the tissue which occurs when it is placed in NaCl and also the rise of resistance which occurs in $CaCl_2$ (which is always followed by a fall of resistance).

In the hope of throwing some light upon this process sections of the tissue were observed in $CaCl_2$ under the microscope. It was then seen that after a time the protoplasm assumed a coagulated appearance: it seemed obvious that the process which increased the viscosity might produce a coagulation of the protoplasm or some other change in its structure whereby it became more permeable.

This conception led the writer to expect decreased resistance in tissues placed in NaCl (because of decreased viscosity) while in $CaCl_2$ we should expect to find increased resistance (due to increased viscosity) followed by a fall of resistance (due to coagulation or other structural change in the protoplasm).

It soon became apparent that there were several serious objections to this conception. The most important of these may be briefly stated as follows:

1. If to a solution of NaCl we add $CaCl_2$ until the increase of viscosity produced by one salt is just balanced by the decrease produced by the other, the resistance should remain stationary. This is not the case, though it seems to be so when the observations are not taken frequently enough (as happened in some early experiments). There is always a fall, or a rise followed by a fall, of resistance.

2. If more $CaCl_2$ be added there should be a rise of resistance: this should after a while become stationary, provided there is not enough $CaCl_2$ to produce the coagulation or other structural change which decreases the resistance. This does not occur: the tissue never maintains its increased resistance, but shows a fall of resistance which begins soon after the maximum is reached.

3. If still more $CaCl_2$ be added, so as to produce the coagulation or other structural change which decreases resistance, we should expect to find in all cases the same viscosity (and consequently the same maximum of resistance) just before the fall begins. Still further increase of $CaCl_2$ would only hasten this process without changing the maximum. This does not correspond with the facts. The maximum steadily rises as the proportion of $CaCl_2$ increases, so that the greatest maximum is found in pure $CaCl_2$.

4. If the fall of resistance in $CaCl_2$ is due to coagulation or to some other structural change it might be expected to be irreversible almost from the start; but this is not the case. Only when it has proceeded a good way toward the death point does it become irreversible. On the other hand the fall in NaCl (due to liquefaction) might be expected to be reversible at every stage. But it ceases to be wholly reversible after it has proceeded one sixth of the way (or less) to the death point.

5. The effect of anions on the permeability of *Laminaria* is completely at variance with their effect on the viscosity of colloids as seen in Hofmeister's series.

6. Since the changes in viscosity occur in dead as well as in living tissue we should expect to find in both cases similar changes in resistance. It is found that the decrease in viscosity in NaCl produces no appreciable effect on resistance. Even when the process proceeds so far that the tissue is reduced to a very soft jelly there is little or no change in resistance.[3] The hardening in $CaCl_2$ produces some rise in resistance, but it is much too

[2] Throughout this paper NaCl and $CaCl_2$ of the same conductivity as sea water are referred to.

[3] In a liquid a change of viscosity alters the resistance, but this is not necessarily the case in a gel.

small to account for the great changes which occur in living tissue.

It might be supposed that the reason that no change in resistance occurs in dead tissue is because the hardening and softening do not proceed as far as in living plants, but this is not the case. Moreover, it is found that the increase of viscosity in NaCl is accompanied by absorption of water, while the decrease of viscosity in $CaCl_2$ is accompanied by loss of water, and these processes take place in the same way in living and dead tissue.

It would seem that these and other important objections must be removed before we can accept the idea that changes in permeability are determined by changes in viscosity.[4]

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POLLEN STERILITY IN RELATION TO CROSSING

IN view of the recent revival of the old idea that pollen sterility is a universal and safe criterion of hybridity in plants[1] we found it of interest recently to examine the pollen of some California plants with this idea in mind.

The first species examined, *Trillium sessile* var. *giganteum,* perhaps better regarded as *T. giganteum,* a separate species from the *T. sessile* of the eastern states, is found in quantity in Strawberry Canyon, Berkeley, where it is now in full bloom. It is already known that this species shows a remarkable degree of variability, especially in the color and width of the petals. In color the petals vary from dark purple through pinks to nearly white, and also through yellows to nearly pure green. One of us is making a detailed study of these variations. The former color series, combined with the width series, is found on one hillside in Strawberry Canyon, the greenish and yellowish series occurring across the bay in Marin County. No other Trillium occurs in this canyon, but a variety of *T. ovatum* occurs along with *T. giganteum* in various parts of Marin County. The two forms are not closely related, however, and it is extremely doubtful if they ever cross. In Strawberry Canyon at any rate there is no possibility of *T. giganteum* crossing with any other species, yet some plants collected here show a considerable amount of sterile pollen.

In all the pollen examinations the grains were only considered "bad" when they were obviously shrivelled or greatly undersized, so that the amount of non-viable pollen would doubtless be considerably larger than the percentage recorded here as bad. The highest amount of bad pollen recorded from any normal plant of *T. giganteum* from Strawberry Canyon was 18.2 per cent., and the lowest 3.2 per cent. In another plant having certain abnormalities of the flower the percentage was as low as 1.5 per cent. In five plants from Camp Taylor, Marin County, where the species grows in company with *T. ovatum,* the percentages of bad pollen were respectively 7.3, 5.6, 3.9, 3.2, 2.3. Thus the amount of defective pollen is not high in any of the plants examined, with one exception, though the pollen grains are never all perfect.

The form of *T. ovatum* occurring in Marin County is remarkably uniform, in contrast with the variable *T. giganteum.* The pollen from seven plants of *T. ovatum* was examined, and they were found to have respectively 7.3, 7, 5.3, 4.5, 4.2, 3.9 and 3.9 per cent. bad pollen grains. Thus a species which is very invariable in this locality and which we can be quite certain does not cross with *T. giganteum,* nevertheless produces regularly a certain percentage of shrivelled and misshapen grains.

Still more conclusive evidence regarding the occurrence of considerable quantities of bad pollen in the absence of crossing was furnished by *Scoliopus.* This remarkably isolated genus of the Liliaceæ contains only two species, *S. Bigelovii,* which is confined to California from Santa Cruz to Humboldt County, and *S. Hallii,* which occurs in western Oregon. In plants of *S. Bigelovii* collected in Marin

[4] It would appear that the term viscosity is loosely applied to a variety of phenomena which may be produced in different ways.

[1] Jeffrey, E. C., 1915, "Some Fundamental Morphological Objections to the Mutation Theory of DeVries," *Amer. Nat.,* 49: 5–21, Figs. 7.

County, where all possibility of crossing is excluded, there was found a most unexpected amount of shrivelled pollen grains. One flower was examined from each plant. The flowers have three anthers and in some cases anthers from the same flower yielded different percentages of bad grains. Yet the anthers, and the plants as a whole, were all entirely normal in appearance. The amounts of bad pollen are shown in the following table:

Pollen of Scoliopus Bigelovii

Plant	Bad Grains Per Cent.	Individual Anthers Per Cent.
No. 1.....	31.9	45.4
		25.8
		33.2
No. 2.....	20.6	—
No. 3.....	18.5	6.4
		25.6
		6.5
No. 4.....	10	10.7
		9.04
No. 5.....	9.9	11.1
		7.8
		10.4
No. 6.....	3.75	—
No. 7.....	3.25	—

Thus, in the absence of crossing, these plants in their normal habitat produce from 3 per cent. to 32 per cent. of bad pollen, and in individual anthers the observed amount exceeded 45 per cent. This in itself is a sufficient refutation of the hypothesis that bad pollen is necessarily a sign of hybridity. It would be difficult to find a plant which is more suitable for disproving this hypothesis than *Scoliopus Bigelovii*. It furnishes all the conditions that the most captious critic could desire, including relative uniformity and the absence of a related species with which it might cross. Yet, with two exceptions, it shows a higher percentage of bad grains than any other plant examined.

Dirca occidentalis furnishes an even more convincing proof that bad pollen may occur in quantity in plants that are not hybrids. This shrub belongs to an isolated genus of the Thymeleaceæ, the only other species being found in the eastern states. Pollen examined from three separate flowers on the same branch yielded respectively 8.7 per cent., 20.8 per cent. and 46.6 per cent. of bad grains. Many of the pollen grains are also conspicuously undersized, so that the amount of nonviable pollen in this plant apparently often far exceeds 50 per cent.

The pollen of two other species taken at random has also been examined, with the following results.

Ranunculus Californicus showed in one case 21.7 per cent. bad pollen and in another case 4.4 per cent. The pollen of *Fritillaria lanceolata* var. *floribunda* appears to contain regularly more than 50 per cent. of bad grains. These are both variable species, and in this case the possibility of crossing is not excluded. They are included here so as to avoid the publication of selected results.

It is certain, then, that bad pollen, even when it occurs in large amount, is not necessarily an indication of hybridization. Pollen sterility is rather a physiological condition which occurs in all degrees of intensity and may be due to a variety of causes. Hybridization is of course one of these, but only one.

Multiple causes apply in the same way to the conditions of sterility in animals. The mule is sterile because it is a hybrid whose parents are not only very dissimilar but have different chromosome numbers.[2] On the other hand, the various species of the genus *Bos* apparently intercross freely without any sign of sterility.[3] To cite one other case of sterility of an entirely different character, Morgan[4] showed that in certain generations of Phylloxerans in spermatogenesis, half the sperma-

[2] Wodsedalek, J. E., 1916, "Causes of Sterility in the Mule," *Biol. Bull.*, 30: 1–57, Pls. 9.

[3] Similarly, Dorsey ("Pollen Development in the Grape with Special Reference to Sterility," Univ. of Minnesota Agric. Expt. Sta., Bull. 144, 1914) concludes that in grapes hybridity is not necessarily a cause of sterility, since both sterile and fertile hybrids occur among cultivated varieties.

[4] Morgan, T. H., 1909, "A Biological and Cytological Study of Sex Determination in Phylloxerans and Aphids," *Jour. Expt. Zool.*, 7: 239–352, Pl. 1, Figs. 23.

tids (those lacking the accessory chromosome) regularly degenerate. This obviously has no connection with crossing, but is concerned with sex.

If we were to classify the causes of pollen sterility we might at least mention the following: (1) Crossing of sufficiently distinct species, (2) a condition of variability or mutability in the species, (3) the substitution of vegetative for sexual reproduction, (4) unknown physiological causes.

So far from it being improbable that mutability in a species should be accompanied by a certain amount of pollen sterility, we should be at a loss to account for the reverse condition, namely, a highly mutable species which had perfectly good pollen. For it is clear that in a mutating species various types of aberrant pollen grains must be produced, some of which may be unable to mature, and these will form shrivelled grains. This view is borne out by direct observations of pollen development in the Œnotheras. Moreover, some such gametes will form zygotes which are unable to develop, as has again been shown by direct observation in Œnothera. It follows almost from necessity that if the gametes of a mutable species are varying in many ways some of them will vary so as to produce pollen grains which are non-viable.

The view that a great increase in the vegetative methods of reproduction in a species may lead to or be accompanied by partial sterility of the pollen, is often expressed and apparently with reason. How narrowly such a relationship holds, however, could only be determined by statistical comparison. In the case of *Trillium, T. giganteum* apparently reproduces largely from rootstocks and *T. ovatum* chiefly from seeds.

From these preliminary observations it is clear at any rate that geographically isolated species do not invariably have good pollen, and that pollen sterility is by no means a sure sign of hybridity.

R. R. GATES,
T. H. GOODSPEED

UNIVERSITY OF CALIFORNIA,
March 16, 1916

ANTHROPOLOGY AT THE WASHINGTON MEETING

III

Indian Ruins of the Republic of Guatemala: FERNANDO CRUZ.

The ruins scattered throughout the territory of Guatemala are of two characteristic types: (1) Those properly classed as prehistoric, consisting of cities which were inhabited by races who occupied the territory centuries before the Spanish conquest and left notable vestiges of their civilization. (2) Those of a later period which were the fortifications used by the natives in their resistance to the Spaniards.

Those of the first class have been studied with care, at least the greater part of them; those of the second class have been viewed up to the present time with but little interest by archeologists. The ruins of this second class are simpler and do not reveal in their construction the same high grade of architectural beauty as those of the first class.

The author mentions the principal Indian ruins of Guatemala which have been studied, as well as those that have not yet been studied. He also gives a general idea of the arrangement of the cities, some of which he briefly describes.

With regard to the ruins of the cities contemporary with the Spanish conquest, the author notes that they reveal certain artistic decadence, and that in none of them is there to be found anything like the monoliths and sculptures of the former inhabitants. These ruins are of cities of a military character, fortifications intended for the resistance of the enemies in their domestic wars. The author indicates some of these ruins, and describes the condition in which they are to be found.

Native Languages of Guatemala: ADRIAN RECINOS.

After a few preliminary considerations with regard to the problems which demand the attention of the scientific men occupied in the study of the pre-Columbian epoch, the author proceeds to a study of the native languages of the races that have inhabited the Central American territory. He gives an outline of the Maya race and the grade of civilization which it attained.

The author does not believe that the native Central American languages can be described as dialects of the Maya. In his opinion they are perfect languages, with a construction, and some of them with a literature of their own.

Studying the different native races which inhabit Guatemala at the present time, and analyzing

their relations, the author concludes that they may be classified in the following groups: (1) The primitive language; the Sinca. (2) Maya-quiches, Mopán, Chol, Chortí, Quechí, PoconchíQuiché, Cachiquel, Zutijil, Pocomam, Mam, Aguacateca, Ixil, Uspanteca, Chuj y Jacalteca. (3) Languages of Nahuatl origin, Pipil, Alaguilac. (4) Caribes.

The author studies with care each one of these ethnic groups and the languages which they speak.

The report contains a bibliography and is accompanied by photographs of some of the types of Indians of Guatemala.

Sources of Cuban Ecclesiastical History: Rt. Rev. Charles Warren Currier.

History of the Cuban Church divided into five periods. Sources for each of these are given by the author, who laments the irreparable loss of manuscripts relating to the earliest history of the church in the West Indies. Among the more noted sources should be mentioned the Archivo Nacional of Havana, especially the large collections of manuscripts in Escota's library.

The Social Revolution of the Eighteenth Century in South America: Bernard Moses.

The society of Spanish South America at the beginning of the nineteenth century had departed widely from that which its founders proposed to establish. A point was reached somewhere in the colonial history where the ideals of the mother country ceased to dominate completely the life of the colonies. The greater part of Spain's constructive work in colonizing was done in the middle period of her colonial history.

Spain aimed to reproduce the European form of society in America: class distinctions, a titled nobility, feudalism, and a state church with great authority. When the colonies had become conscious of their individuality as communities, the influence of their environment led them to revolt against a social organization suited only to other circumstances. This revolt was strengthened by Spain's excluding creoles and mestizos from high office, in spite of their fitness. Growth of mestizo class was encouraged by preventing unmarried Spanish women from emigrating. In spite of local differences among populations of different districts, the creoles, mestizos, and the more cultivated free Indians were thrown into one class by the action of the Spanish government. This union was favored by the fact that Spain had adopted the Indians as an element of colonial society. Primary elements of that society were the *encomenderos* and their Indian dependents. A middle class grew later, composed of landless creoles, mestizos and free Indians. The upper class embraced Spanish officials, the nobility, and the clergy. The creole-mestizo class grew by natural increase faster than the Spanish class by immigration. The line of separation became fixed, with the more rapid growth on the part of the creole-mestizo class. The physical growth was not more rapid than the growth of new ideals and new aspirations; whence the holders of ancient Spanish ideals became a declining minority.

Spain's persistence in governing according to her established rigid, exclusive policy drove the two sections of the population farther and farther apart. When the creole-mestizo class became conscious that its interests were opposed to the purposes of the Spanish government, the social revolution was complete on its spiritual side. The later discussions, agitation, rebellions and military campaigns were only required to convince Spain and the world of the reality of the change.

A Forgotten Cereal of Ancient America: W. E. Safford.

Among the tributes paid to Montezuma by the various pueblos of Mexico were maize, beans, cacao, capsicum peppers, maguey syrup and bees' honey, salt, salvia seeds called *chian,* and *huautli* or *guautli.* Concerning the last-named, Albert Gallatin wrote as follows: "I can not discover what is meant by *guautli.* It is interpreted as being *semilla de bledo;* but I am not aware of any other native grain than maize having been, before the introduction of European cereals, an article of food of such general use, as the quantity mentioned (an annual tribute of 18 granaries full, each granary containing about 9,000 bushels) seems to indicate."

This seed was described in 1629 by Hernando Ruiz de Alarcon as "smaller than mustard seed" and ripening when the temprano maize begins to tassel. The Mexicans made of it certain dumplings (*bollos*), "which in their language they called *tzoalli,* and these they eat cooked like their tortillas." It was of these seeds, ground and made into paste, or dough, and mixed with agave syrup, that they made certain idols in human shape which they placed upon altars and to which they made offerings of pulque, incense and lighted candles or splints of pitch-pine (*ocotillos*). The following day the idols were divided into small pieces and administered to the worshippers like communion. Padre Acosta (1590) speaks at

length of the use of this seed in the worship of the god Uitzilipuztli. In his honor an idol was made by young virgins, who "*molian quantidad de semilla de bledos juntamente com mays tostado, y despues de molido amassabanlo con miel.*" It was undoubtedly this grain which Alvar Nuñez Cabeza de Vaca found on the west coast, where it took the place of maize as a food-staple. He refers to the plant as *bledos*, and states that the natives ate nothing else than flour made of it. The identity of the plant called *huautli, uauhtli,* or *guautli,* has long been a mystery. In the economic collections of the United States Department of Agriculture are certain seeds collected by the late Dr. Edward Palmer at Imala, Sinaloa, bearing the vernacular name "*guaute,*" which are used for food when maize is scarce. They are ground into paste, mixed with brown sugar, and made into balls called *suales,* which are wrapped in corn-husks and sold in the markets of Jalisco in strings called *rosarios de suale.* The seeds have been identified as those of *Amaranthus cruentus* L., a species closely allied to *A. caudata* L. At Colima Dr. Palmer saw a handsome variety with red spikes occurring both in cultivation and spontaneously, and in the vicinity of Guadalajara, both red and yellow varieties cultivated either alone or among maize. This species has a white-seeded form which was described by Sereno Watson as *A. leucocarpus.* It is interesting to note that very closely allied, if not identical, species, also having white-seeded forms, are cultivated as cereals in Tibet, the mountains of India, and in Peru and Bolivia.

Food Plants and Textiles of Ancient America: W. E. SAFFORD.

This paper is based on collections and observations by the author in Chile, Peru, Bolivia and Mexico, supplemented by the study of additional material from those countries and from various parts of the United States derived from ancient graves, cliff-dwellings, caves and prehistoric burial grounds. From prehistoric mounds and ancient village sites in the United States the only vegetable products preserved are those which have been charred by fire. From dry caves and cliff-dwellings of southwestern United States, food-products have been found in good condition, while from ancient graves of the arid coast region of Peru and northern Chile the organic material is in a remarkably perfect state of preservation. Not only such staples as maize, gourds, beans and peanuts, but leaves of *Erythroxylon coca,* soft pulpy fruits, including the lucuma, the chirimoya and various starchy tubers have been collected.

In addition to the fruits, seeds, grains, tubers, roots and leaves, many of which have already been recorded by Wittmack and others, beautiful representations in terra-cotta of these and other vegetable products have also been unearthed, principally in the vicinity of Trujillo and Chimbote, Peru. Casts of maize, squashes, peanuts, etc., occur on burial vases. Often the original model has been reproduced so accurately that the varieties are clearly discernible.

The paper deals with actual specimens concerning which there can be no doubt, dug up from prehistoric graves and discovered on the sites of ancient habitations. Among the most interesting objects to be shown are specimens of the "almond of Chachapoyas" (*Caryocar amygdaliforme*); the balsam of Peru, found in a calabash in a grave at Ancon; a ceremonial planting-stick with an ear of maize attached, represented in terra-cotta; a remarkable carving in stone from the vicinity of Oaxaca, Mexico, representing ears of maize; and specimens of maize from prehistoric graves of Chile, Argentina and Peru; from various parts of the southern United States, including mounds of the Mississippi valley, and from ancient village sites farther north. In connection with textiles, cotton cultivated by the ancient Peruvians and by the Indians of our own southwest will be shown; and, among other fibers those of various eurcæas, agaves and yuccas, of tropical America and southwestern United States.

The Puma Motive in Ancient Peruvian Art: CHARLES W. MEAD.

In the present state of our knowledge it is impossible to treat of the decorative art of the prehistoric Peruvians otherwise than as a whole, and no attempt has been made at a chronological sequence. The decorative motives most commonly employed are from the human figure, birds, fish and the puma, and these, together with such designs as undoubtedly owe their origin to the textile art, form a large part of the decorations found in Peruvian cloth and on the pottery vessels. The object of this paper is to show to what an extent the puma figures in Peruvian art, and to attempt the identification of some of the highly conventionalized designs.

The Rise of the Inca Empire: PHILIP A. MEANS.

Explanatory introduction summarizing reasons

for accepting Garcilasso's rather than Sarmiento's version of the rise of the empire.

A short survey of conditions in the Andean area prior to the rise of the Incas.

The reigns of the earlier Incas, those before Inca Rocca, briefly considered, the accessions of territory gained by each one (except the first two) shown by maps. The reigns of the Incas from Rocca to Huira-ccocha, inclusive, considered with special reference to the Chanca rebellion. A rather full enumeration of the conquests made by Pachacutec, together with a few remarks on the buildings erected by him and on the reforms in administration he introduced. An account of the reign of Tupac Yupanqui, with a presentation of the evidence pointing to his having reached some islands in the ocean out of sight of land. Concluding remarks, the empire at its zenith, the cataclysm.

A complete bibliography of works referred to in the paper.

Notes of Venezuelan Archeology: Luis I. Oramas.

The present paper contains the description of archeological exploration made by the author in the western and southwestern part of Venezuela. The region explored comprises the states of Aragua, Carabobo, Cojedes, Portuguesa, Zamora and Apure.

The first part of the paper refers to the exploration of the islands and shores of the lake of Valencia and other adjacent places. The tumuli and mounds of earth made by human hands, and the implements and human remains found, are described. According to the author not all of the mounds contained bones and implements; in some of them only bones alone are found. The author refers expressly to the vessels which he discovered in the interior of the lake, vessels which the Indians filled with human ashes.

The second part of the paper is confined to the causeways and mounds of the plains of the states of Portuguesa and Zamora. The causeways or elevations of consolidated earth, of variable height and slope, are constructed in the lowlands, which are flooded in the rainy season. The causeways frequently communicate with mounds similar to those in the United States which are referred to as having been made by the mound builders. The author describes these mounds and the objects which he discovered in them after making his excavations. The author thinks that these monuments were not constructed solely as tombs, but also as sacred places, and chiefly as military observatories. The author describes in detail and separately the different causeways and mounds visited by him.

In the third part of the paper the author refers to the tribes to which belonged the aborigines who peopled the states of Portuguesa and Zamora.

The paper, which is accompanied by lists of works consulted, contains a series of photographs and a map of regions in which the explorations were made.

Jade in Brazil: Antonio Carlos Simoens da Silva.

The prehistoric art products of jade and of rough jade, all found in the state of Bahia. The locality where these art products, in a certain abundance, and the rough material have been found, suggesting their existence in various beds. The variety of very hard rocks, their existence, accompanying the jade. Explorations made by the writer and trustworthy opinions on the subject given by the inhabitants, some of them differing from those presented by Mr. Ehristovam Barreto. The analysis and the specific weight of this green rock and its pretended curative property. The opinion of the Brazilian inland people about these art products.

The Grindstones of the Primitive Inhabitants of Cabo Frio, Brazil: Antonio Carlos Simoens da Silva.

Some of the Indian tribes who inhabited formerly, by preference, the coast regions of Brazil. Their permanence in the old captaincy of "São Thome," to-day state of Rio de Janeiro. Their large grindstones in "Cabo Frio," county of this Brazilian state, where they prepared their arms and utensils. The accurate study of ten of these granite blocks, their measurements and their grooves.

References to the other class of Indian grindstones, named "shingles," which they carried with them.

The Alaculufs and Yahgans, the World's Southernmost Inhabitants: Charles Wellington Furlong.

The Fuegian Archipelago lying south of the Strait of Magellan and the Patagonian Archipelago, lying north of it, is a grand, desolate region with precipitous shores covered mostly with rain-soaked bog and impenetrable forests. We find among the four primitive tribes occupying it, two which are canoe peoples, the Alaculufs to the west and north, the Yahgans to the east and south.

The names of both these tribes having been made authoritative by the Rev. Thomas Bridges, the nomenclature of these regions indicates much of its history.

The Fuegian tribes were probably pushed south by stronger northern tribes, the canoe people down the Patagonian channels, the foot people of northern Tierra del Fuego and Patagonia down the Pampas of the latter territory. The Andes and the Strait of Magellan prevented communication between the various tribes and may have been responsible, in part or in whole, for the difference in their languages.

The Yahgan language (Yatigan) was found by the Rev. Thomas Bridges, who wrote a remarkable Anglo-Yatigan dictionary and grammar to consist of at least 40,000 words. This will stand as the greatest piece of linguistic work ever done in connection with these people.

Of the Alaculufs little is known. No white man, as far as is known, has ever spoken their language. They formerly seemed the most numerous of the Fuegian tribes. Now they are fast disappearing.

The Yahgans are the southernmost people in the world. Their environment made them canoe people and forced them to a nitrogenous diet through limited food supply; it also made them nomadic, in consequence preventing them from establishing large or permanent communities and from developing a tribal authority or any form of tribal government. Consequently they are socialistic. This lack of gregariousness has probably affected their religion, which is more or less animistic and without any form of worship. They are without chiefs or gods.

Many kitchen middens composed mostly of heaps of débris show their village sites. In one of these I found the world's most southern "perforated stone" with knobby projections. It is now in the American Museum of Natural History. The exhuming and study of these should be undertaken systematically.

The Yahgan's stunted stature may be accounted for by his squatting in canoes. Young Yahgan men of the present generation who have lived on land, herding sheep for a missionary rancher, are well proportioned.

The gap between primitive and civilized man I believe to be very narrow. The white man's contact with the Alaculufs and Yahgans has been their undoing, particularly through the forcing of clothes upon them, cutting their hair, and the introduction of syphilis and various venereal diseases; measles, whooping cough and smallpox have swept them off like a plague.

The Yahgans have decreased in 46 years from about 2,500 to about 100. There still remains important scientific work to be done among these people, but whatever is done must be done soon.

The Tribes of the Fuegian Archipelago: CHARLES WELLINGTON FURLONG.

The Fuegian Archipelago—its nomenclature—its autochthonous inhabitants, and their linguistic divisions. The four tribes—the Alaculuf, Yahgan, Haush and Ona. Geographical distribution of these tribes. Origin of their tribal names. Brief consideration of their languages. Proto-history and history. Their environment, its effect on their distribution, physique, language and social organization. The effect of food on their social organization. The number of present and past aboriginal populations of the Fuegian archipelago. The effect of white civilization on the Fuegians, showing causes and effects.

Fuegian and Chonoan Tribal Relations: JOHN M. COOPER.

The Fuegian archipelago is inhabited by three distinct tribes—the Onas of Tierra del Fuego, the Yahgans of Beagle Channel and the southern islands, and the Alacalufs of the remaining territory. The three tribes speak languages that are lexically at least quite distinct, while from the physical and cultural standpoints the Yahgans and Alacalufs agree much more closely with each other than with the Onas.

The Onas show Tehuelchean affinities. They are divided into two subtribes, the Shílk'nam and the nearly extinct Mánekenkn, who, though culturally and physically uniform, speak quite different dialects.

A comparison of fifteen available vocabularies and some additional stray words shows with fair clearness that the Alacalufan tongue is spoken by all the non-Yahgan canoe-using Indians of the channels and inlets north and south of the Strait of Magellan, and up the west Patagonian coast as far as Port Grappler or Messier Channel.

The Chonos, now perhaps extinct, spoke a non-Araucanian and non-Tehuelchean language, but whether it was a distinct stock or an Alacalufan dialect is uncertain. Somatologically and culturally the Chonos were closely akin to the modern Alacalufs. Certain cultural elements, including apparently the plank boat, filtrated down the Chilean coast south of Chiloé from Araucanian sources.

The Army Medical Museum and American Anthropology: D. S. Lamb.

The Army Medical Museum at Washington began to receive Indian crania in 1867. In 1868 a circular was sent to medical officers of the army asking for Indian skeletons, crania and "curiosities." The crania received were measured and the results published. By 1877 there were nearly 2,000 crania in the museum. In 1884, in the progress of the study by another officer, a new method of measuring the capacity of the skull was devised, also a craniophore; and composite photographs of skulls were made. In 1887–88 a large number of crania and skeletons were obtained from prehistoric ruins in the valley of the Gila in Arizona. These also were measured and studied, and the results published. Altogether the basis of the several publications consisted of three to four thousand skulls.

The Permanent Teeth, with special reference to American Children: Robert Bennett Bean.

The teeth of the Filipinos appear from one to four years earlier than in American whites; of the French six months to one year earlier; of the American Indians one to six months earlier, and of the Germans six months to two years later.

The great difference between the Filipinos and other peoples is that the canines of the Filipinos erupt much earlier.

The girls are more precocious than the boys, but the difference is not so great among the Filipinos, and is greatest among the whites.

The canines and third molars are undergoing retrograde metamorphosis, as indicated by their size in prehistoric times and to-day. The Filipinos and Indians, in whom the canines and molars erupt early, are more like the prehistoric men than are the Germans and Americans, in whom the canines and molars erupt late.

Hyper-morphism, long head, nose and face and long occiput is a condition (1) of precocity, (2) of unsound teeth, (3) of greater age, (4) of the male sex, (5) of the American white, (6) of development more complete; whereas hypo-morphism, broad head, nose and face and large parietal, is a condition (1) of retardation, (2) of sound teeth, (3) of less age, (4) of the female sex, (5) of the Filipino and (6) of development less complete.

The following supernumerary teeth were seen:

Among 146 Filipino girls, none.
309 German girls, none.
412 American girls, 1 upper and 1 lower incisor.
579 Filipino boys, 2 upper incisors, 1 upper canine.
324 German boys, none.
415 American boys, 1 upper incisor.

Racial Elements in the Modern Population of America: Franz Boas.

Three types may be distinguished among the modern populations of the American continent—those in which the indigenous element forms a high percentage, those with a strong negro admixture, and those derived almost entirely from European sources. In comparison to these, the populations with strong Asiatic affiliations are unimportant. The regions in which the pure aboriginal population forms a large part of the modern population are few and restricted in extent. The political development of American states is very largely dependent upon the prevalence of one or the other of these types of population. The study of these types and the practical questions involved in their composition present a number of important problems. In these populations in which the aboriginal blood predominates or forms a large part the effects of racial mixture must be studied.

In all these regions the mixture proceeds in both directions, marriages between native men and European women and vice versa being of nearly equal frequency. Material for answering the biological questions involved is very inadequate. It has been shown that in the United States the physical development of the half-bloods is superior to that of the parental types, and that the fertility of the half-blood women is greater than that of women of pure race. The claim has been made that racial traits of the Indians and of the whites are inherited according to Mendelian laws; but no adequate proof of this contention can be given. In those regions in which there is a strong infusion of negro blood, conditions differ considerably in Latin America and in Anglo-Saxon America. In the former regions marriages between men and women of the two races are almost equally frequent. In the latter region marriages between white men and negro women form the vast majority. These conditions have a far-reaching influence upon the development of the resulting population. In the former case a permeation of the two races results in a mixed type, with almost equal amount of blood contributed by each side,

in accordance with the number of individuals in each race. In the latter case a constantly increasing amount of white blood will be found, because the fertility of the negro male is materially reduced while that of the white male is considerably increased. For this reason the result of the mixture consists in the development of a population in which white blood will more and more preponderate.

The problems in regions of pure white population are still different. The claim that the amount of mixture of European types that occurs in America is infinitely greater than in corresponding mixture that has occurred in previous times in Europe can not be maintained. Mixture of distinct types owing to migration and intermarriage has been the rule in earlier periods in Europe, and events in America are a repetition on a larger scale of earlier phenomena in the development in European populations. The stability of European social units is largely a phenomenon belonging to the stable agricultural conditions which prevailed until the beginning of the nineteenth century. With the industrial development this stability has been broken. Since conditions in America are quite analogous to those that have prevailed in Europe for several thousand years, there is no reason to assume any detrimental influence owing to the contact of different types in our country.

Heredity of Stature: C. B. DAVENPORT.

The study of the heredity of stature by Galton laid the foundation of biometry and has always been a favorite one for the biometrician who has believed it incapable of Mendelian analysis. Such analysis has, however, been attempted, and, although additional investigations have still to be made on the subject, it is even now clear that stature is not determined merely by general growth factors, but that there are five principal elements that are separately inheritable and form combinations of which the diverse statures of a hybrid family can be in major part explained.

United States Census of Immigrant Stocks: DANIEL FOLKMAR.

In 1910 were presented for the first time in the census figures directly relating to the ethnic composition of the white population of the United States, in so far as that is indicated by the native languages of the foreign born and their children in the United States. A great numerical preponderance is still held by the mother tongues of northwestern Europe. The German is larger than the English or any other single foreign stock in the United States, as thus defined. It contributes more than one fourth of the entire last two generations of immigration. The English-Irish-Scotch-Welsh mother-tongue group numbers 10,037,420, and combined is only about 1,200,000 greater than the German mother-tongue stock.

The "new" immigration from southern and eastern Europe is still a small factor numerically. Taking as 100 per cent. the total white population of the United States in 1910, numbering 81,731,957, the so-called native stock constitutes 60.5 per cent. and the three great linguistic families of foreign stock from northwestern Europe constitute 27.1 per cent., making a total of 87.6 per cent. The elements from southern and eastern Europe constitute, therefore, less than 13 per cent. of the total. Of this, the two principal Latin mother tongues of the United States, the French and the Italian, contribute less than 5 per cent.

Of the total foreign white stock of the United States, 32,243,382, there are 8,817,271 persons who are of German stock. Of the foreign-born white element of the United States, 25.2 per cent. are reported as English, Irish, Scotch, Welsh and Manx in mother tongue and 21.8 per cent. are reported for the Germanic languages. Russian immigration is shown to be far more Hebrew (52.3 per cent.) than Russian (2.5 per cent.) or even Slavic.

The Spanish mother tongue contributes a much larger proportion of the total foreign-born white element than does the corresponding country of birth, Spain. The excess comes mainly from Mexico and other countries south of the United States. South America shows a decrease in the number reporting Spanish its principal mother tongue as represented in the United States. The contingent from Cuba is over 95 per cent. Latin—that is, mainly Spanish—while the representation in the United States from the other West Indies is, on the contrary, over 70 per cent. English, less than 10 per cent. being Latin.

Anthropological Study of Old Americans: ALEŠ HRDLIČKA.

Old Americans, for the purpose of this study, are those whose parents and all four of whose grandparents were born within the territory of the United States and have no colored admixture.

Physical and to some extent also physiological investigations on this now very numerous, and at the same time rapidly diminishing, stock have

been carried on by the writer now for three years. The object of these investigations is twofold. In the first place they are expected to show what, if any, bodily and functional changes have taken place in the descendants of early whites under prolonged action of American environment; and, in the second place, they are to give us a series of much-needed standards, for use in anthropological comparisons.

The study is limited to healthy adults between 24 and 60 years of age, and no selection whatever is made beyond this requirement; in fact the work is purposely confined to the District of Columbia, where the old American population is derived from all vocations and from all parts of the country. The number of individuals of each sex to be examined was set at from 150 to 200, and the lower limit has now been nearly reached with both males and females.

The results of the research are most interesting. In general, it may be said that no homogeneous American type exists, even in the very oldest families; ancestral traits often persist in a remarkable manner; yet on the whole there are unquestionable evidences of a tendency towards the formation of a purely American subtype. In other words, there are evident, on the one hand, the power and persistence of heredity, while, on the other hand, we can also trace the effects of local American acquisitions. Yet there is little probability that a national type will develop in this country within the next few centuries; the old families are dying out or mixing with newcomers, and immigration will keep on pouring in fresh foreign strains. Even should immigration stop, there is little probability that a single American type would ever develop, but we should expect rather several subtypes, due to the basic regional differences in the components of the population, jointly with differences in environment.

The Genesis of the American Indian: Aleš Hrdlička.

The author of this paper considers the question of the unity or plurality of the American race. In answering this question he decides in favor of the original unity of the Indian race in America. He bases his conclusion upon the similarities of language, culture, mentality and physique. The author next takes up the question of the antiquity of the race on this continent. He does not think that the Indian was autocthonous on this continent. He bases this belief upon the absence of the inferior primates of the anthropoid type on this continent, also upon the subject of the unity of the human species and upon the circumstances that the primitive types of humanity living in Europe during the quaternary or glacial epoch could not have come from America. According to the author no human remains of geological antiquity have been demonstrated to exist on this continent.

The third question considered is the source of the elements that occupy America and the epoch of the occupation.

With respect to the first point the author passes in review the means of transportation of prehistoric man. The geographical situation of America with respect to the other continents; the anthropological characteristics of the American Indian, which compare with the primitive characteristics of the great ethnic groups of other parts of the world. The author concludes from these considerations that the American aborigines could have come only from Asia.

With respect to the epoch, the author thinks that no direct proof exists upon which to base an opinion. Considerations or proofs of an indirect character tend toward the idea that emigration to America could not have been effected before the European Neolithic period.

The manner or manners of the arrival of man to the new world and his subsequent dissemination and reproduction there constitutes the last point of analysis by the author. His opinion is that there was not one but many successive immigrations.

Variations in the Lambda of the Crania of the Ancient Peruvians: Carlos Morales Macedo.

In the limited zone between the two occipitoparietal sutures and in the lambda itself, there are observed certain morphological variations, which present in the crania of the ancient races of Peru a frequency not surpassed in the crania of other peoples. The author is of the opinion that in the lambdoid region the Peruvian crania show an anatomical peculiarity.

The interparietal, the epactal and the lambdoids are treated separately. The study is based on the observation of 924 authenticated Peruvian crania, of which 551 belong to the National Museum of Peru, 102 to the Raimondi Museum (School of Medicine), Lima. The remaining 271 were collected by the author in the ruins of Pachacamac and the huacas of Ancon.

The author's conclusions are:

The interparietal is found in 2.7 per cent. of Peruvian crania, which is somewhat higher than in non-Peruvian crania. The crania from Pachacamac, Ancon, Lima, etc., and those from the coast region in general show this anomaly with greater frequency than crania from other regions of Peru.

The wormian lambdoids are present in 56.2 per cent. of Peruvian crania. In the other 43.8 per cent., the lambdoid suture is frequently very complicated. It is possible that the presence of wormian lambdoids in Peruvian crania may have been favored by cranial deformation. The wormian bones of the saggital, coronal, squamose and occipitomastoid sutures exist in the crania of Peru approximately equal to that of the crania of other countries.

With regard to the epactal, he draws the following conclusions: (1) The epactal is present in 21.6 per cent. of Peruvian crania, which is a much higher proportion than in other crania. (2) In crania of genuine Aimara origin, the epactal appears with less frequency than in the crania of other Peruvian origin. (3) It is possible that the greater frequency of the epactal in Peruvian crania may have had for cause the deformation of infantile crania. The deformation would disturb the nutrition of the bone, weakening the tissue of the occipital; such a trophic change would be transmitted through heredity in the form of a predisposition to anomalies in the lambdoidal region.

Trepanation of the Cranium and its Representation in Pottery of Peru: CARLOS MORALES MACEDO.

The evident antiquity of trepanned crania leads to the belief that this was the first operation of major surgery practised by ancient man. Ancient Peru was the place where the art of trepanning was cultivated on the largest scale. From the ancient cemeteries of this country were obtained the greater part of the crania that show trepanation, found to-day in the museums of America and Europe. The most interesting and complete collection among these is the one which Dr. Julio Tello obtained in the canyon of Huarochiri and which Dr. Aleš Hrdlička exhibited recently in San Diego, Cal. The ancient Peruvians have not left us many data with respect to the practise of trepanning the cranium. This is due perhaps to the fact that trepanation was at its height when the ceramic art was but little advanced and to the fact that the Aimara Indians did not cultivate to any high degree the plastic arts. The author has found in a cemetery of Casma a piece of pottery which represents the act of trepanation, which may be described as belonging to the most ancient and imperfect epoch of the ceramic art of Chimu.

The piece of pottery referred to is of a black color, of medium size, and belongs to the class called "silvadores" (whistlers). On one side there is a figure of a man seated with a human head between the legs. With the left hand he is holding the head in position, while with the right he is using a heavy instrument apparently of stone. This instrument is of a length somewhat greater than the width of the head and terminates in a sharp curved edge in the form of a half moon.

Artificial Deformation of the Cranium in Ancient Peru: CARLOS MORALES MACEDO.

This paper on the practise of cranial deformation among the ancient inhabitants of Peru contains several chapters. The first treats of similar deformations among other ancient peoples. The second gives an account of the existence of those operations in Peru during the pre-Columbian epoch. The third relates what the early chroniclers had to say on the subject. The fourth is a study of ceramic art in this connection. The fifth treats of the origin and antiquity of the operation in Peru. The sixth gives a morphological classification of deformed crania in Peru. The seventh and eighth study two forms of deformation. The ninth analyzes the asymmetry of deformed crania. The tenth describes methods employed for deforming the head of the child. The eleventh considers the duration of the compression. The twelfth discusses the motives which inspired the deformation. The thirteenth gives the conditions of the infantile cranium which facilitates the deformation. The fourteenth treats of a mechanical process of the deformation. The fifteenth treats of the effect on health produced by the deformation. The sixteenth reviews the physiological effects and the seventeenth and last considers the question of the inheritance of cranial deformations.

The Fossil Man of Cuba: LOUIS MONTANÉ.

A young priest of Tunas de Sancti Spiritus, Cuba, discovered in 1884 in the mountains of Banao a primitive burial ground, from which Dr. J. F. Torralba received in the same year a small box of fragments of bones. This place, known by the name of Gruta del Burial, was studied by Dr. Montané. It consists of a cavern 7.50 meters long, 4.50 deep, and at its entrance 10 meters high.

According to Dr. P. Saterain, who made a geological study of the cavern, it is of the same calcareous composition as the mountains in which it is situated. It has not been possible to determine the age of the cavern because there were no fossils in it; and the inclination of from 60° to 70° of the calcareous strata, the tertiary strata visible in slopes of the mountain, and other circumstances permit the conclusion that in geological formation it belongs to the secondary and probably to the Jurassic period.

In the bottom of the cavern, resting on a layer of ashes, there were found a number of skulls arranged in a semicircle, and concentric to those, the large bones arranged in the form of an X, and in the same way the short and flat bones were arranged, and at the center the bones of the pelvis. Three of the skulls were studied in Paris under the direction of Drs. Verneau and Rivet in 1906.

In the cave was found also the fragments of a human mandible and a flat stone; and mixed with human teeth a number of other teeth of a strange form. The objects mentioned will be placed on exhibition for the benefit of the members of the congress. The fragment of the human mandible was studied in 1911 by F. Ameghino, who believes that it belonged to a species of genus homo different from those known up to the present time. He gave it the name of *Homo cubensio*. In the opinion of Dr. Roth, of the Museo de la Plata, the mandible and the teeth are those of a species of ape extinct in the island of Cuba, where in historic times apes have not been known.

The study of Dr. Montané is accompanied by an extensive bibliography.

Indian Ceremonial and other Practises on the Human Body: WALTER HOUGH.

Practises on the human body are almost universal, such as tattoo, perforation of lips, nose, cheeks, ears, breasts, etc.; filing, breaking or ornamenting the teeth; shaping the skull, nose, legs, etc.; excoriations by knife and fire, etc. They may be classified as (1) surgical, (2) cosmetic, (3) ceremonial, and (4) thaumaturgic practises, and cause more or less profound modifications in parts of the body. It is probable that they are all based on nature religion. Environment has an important effect on the practises treated in the paper. The majority of mutilative practises occur among unclothed peoples. In America they are found sparingly in the United States and become increasingly prevalent in Mexico, Central America and tropical South America, repeating the phenomena of the East Indies, Oceanica, Africa and such regions as are inhabited by unclothed peoples. Among clothed peoples the visible parts of the body are subject to modifications in the following order: Ears, nose, lips, facial surface and ankles. The practises on these parts survive the adoption of clothing, while tattoo deteriorates or becomes obsolete. The paper describes American practises and illustrates the practises of other parts of the world for comparison.

Preliminary Remarks on the Skeletal Material Collected by the Jesup Expedition: BRUNO OETTEKING.

In preliminary remarks on the skeletal material collected by the Jesup Expedition of the American Museum of Natural History, the speaker points out the variety of racial elements combined in the Indian population of the northwestern section of this continent. So far as the skulls are concerned, the morphological diagnosis of the face will aid materially in conducting investigations. Racial affinities with the peoples of northeastern Asia can be demonstrated in consideration of the bodily proportions manifested in the size and form of the long bones.

One Aspect of Present Evolution in Man: PAUL POPENOE.

Pre-Columbian America was free from the most serious contagious diseases of Europe: tuberculosis, smallpox, measles, etc.; consequently the native population had undergone no evolution or immunization against them. When brought by the conquerors, these diseases immediately began to kill the natives much more rapidly than they did the Europeans, among whom natural selection, by eliminating the least resistant in each generation for many centuries, had produced a strong resistance. In the markedly different death-rate of native Americans and Europeans, with respect to these European diseases, we can see evolution in man actually in operation, and working rapidly to produce a more disease-resistant race in the New World. The high death-rate of negroes in the United States from tuberculosis, as contrasted with the death-rate of whites, offers another illustration of natural selection at work. In the light of such facts, it would be erroneous to suppose that evolution in man has slowed down or ceased; in some directions it is probably proceeding more rapidly to-day than ever before.

GEORGE GRANT MACCURDY

(To be concluded)

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FURTHER EVIDENCE THAT CROWN GALL OF PLANTS IS CANCER[1]

TUMORS without visible cause are the subject of this address. They have been studied most numerously in man, but they occur also in the domestic animals, in wild animals (mammals, birds, batrachians, fish) and now, as we know, in plants. If this paper were given a full descriptive title it would read as follows: *Further Evidence that Crown Gall is Cancer, and that Cancer in Plants because of its Variable Form and its Bacterial Origin offers Strong Presumptive Evidence Both of the Parasitic Origin and of the Essential Unity of the Various Forms of Cancer Occurring in Man and Animals.* This is the text I shall talk to, and in passing I may add it is a view entirely opposed to the current views of cancer specialists.

To make plain what I have to say about plant tumors of this type it will be necessary briefly to mention similar animal tumors. This I shall do without special reference to medicine, *i. e.*, simply from the standpoint of a biologist, but first I shall show you the gross appearance of a few animal cancers. (Lantern slides.)

These tumors without visible cause are very common in man. They have been observed in every organ and in every tissue of every organ. They have been studied diligently by human pathologists, and especially by morphologists, for many years and there is now a great volume of literature respecting their structure and course of development, but very little is known as to

[1] Read before the Washington Academy of Sciences, May 11, 1916.

their cause,[2] and nothing as to the occurrence in them of any causal organism.

Clinically and morphologically they are divided into two well-marked groups—the benign tumors and the malignant tumors. All of these tumors, whether benign or malignant, are abnormal overgrowths (cellular proliferations) of the normal tissues of the body. Every organ and every tissue in which a benign tumor has been observed may also become the seat of a malignant tumor. Moreover, benign tumors sometimes behave like or become converted into malignant tumors. Often, in early stages of growth it can not be foretold whether a given tumor will continue benign or become malignant. Benign tumors are, therefore, always to be considered as a possible source of danger, and their interrelations, if any, with cancers can not be known until their causes are known.

As a rule, benign tumors grow slowly, although often eventually they reach a very large size, exceptionally weighing more than the rest of the body. The cells composing them approximate in form, and in size (that is in maturity), the cells of the normal tissues. Owing apparently to their slow growth, there is also a body-reaction in the form of an enveloping capsule, which shuts off the tumor from the surrounding tissues. These tumors are called "benign" because while they often cause great inconvenience and sometimes death, they are restricted, usually, to the locality where they first appear. That is, they do not develop destructive daughter tumors in other parts of the body.

On the contrary, the cancers, or malignant tumors, with a few exceptions, produce daughter tumors freely (often in vital organs), grow rapidly, are destitute of a restraining capsule, *i. e.*, become invasive, and are composed of cells, which, while showing all grades of transition, are often much smaller and more embryonic in their appearance than cells of the tissue from which they have originated, and are then most malignant. These immature cells are readily distinguished, however, from normal embryonic cells both by their disturbed polarity and by their reaction to stains. In other words, they are not genuine embryonic tissue, because they do not possess either the full structure or the entire capability of embryonic tissue. These cancer cells proliferate freely, sometimes with astonishing rapidity, invade and destroy normal tissues, and in various ways act like a foreign organism, that is, they behave in the manner of a parasite, although they are a part of the body.

Without including all of the forms known, or going into a swamping multiplicity of details, I may say that the cancers, or malignant tumors, may be subdivided into four principal groups: (1) The sarcomas, which are malignant fleshy proliferations of the various types of connective tissue; (2) the cancers proper, or carcinomas (including the epitheliomas) which are destructive (eroding) proliferations of the epithelium of the skin, mucous membrane, and glandular tissues generally; (3) the so-called mixed tumors containing proliferating elements from two germ layers, *e. g.*, the chondro-sarcomas composed of proliferating cartilage and connective tissue, the adeno-sarcomas composed of glandular tissue and connective tissue, etc.; and (4) the embryonal teratomas which, in addition to the cancerous element that is often a sarcoma, contain teratoid elements representing all three germ layers—young

[2] Dass das Dunkel auf diesem Gebiete noch nicht erhellt, des Rätsels Lösung noch nicht gefunden, das zeigt die noch stetig zunehmende Fehde der Streiter auf diesem Felde. Hie embryonaler Keim, hie parasitärer Ursprung, hie Metaplasie, hie Anaplasie, hie Anarchie, so lauten die Schlagworte der Autoren (Wilms).

tissues of various organs, frequently an astonishing mixture of teratoid elements, but all embryonic. These are also known as *atypical teratoids* in distinction from *monsters,* which are pre-natal malformations, and from *typical* (ripe or adult) *teratoids* which also are not cancers, but growths due to pre-natal disturbances, the commonest form of which is the ovarian dermoid. By Wilms they are called solid embryomas or embryoid tumors in distinction from the typical teratoids, which he calls cystic embryomas or simply embryomas.

The atypical teratoids grow rapidly, metastasize freely and are commonest in the early decades of life. In the typical teratoids the fetal fragments have grown with the growth of the host. Although dwarfed, they are as old as the individual out of which they have come, *i. e.,* they contain old skin, old teeth, old bones, long hair, etc. In the atypical teratoids the fetal fragments are always very embryonic and probably are never more than a few months old, or a few years old, no matter how old the person from whom they have been removed, *i. e.,* growth goes on in them independently of the host. Moreover, these atypical teratoids always contain cancerous elements. It is this latter type of tumor that I have recently produced in plants.

In the benign tumors, to return to animals, the tissues are arranged in a nearly or quite normal fashion and the cells are full grown, only much more abundant than they should be. In the malignant tumors the tissues are not only more embryonic, but are arranged atypically, the cells having lost a part or the whole of their polarity, *i. e.,* their orderly arrangement. Frequently, they also show defective mitosis, and very frequently polynuclear cells (the so-called "giant cells") appear, owing to fission and fragmentation of the nucleus without any corresponding cell division. Lobed and cleft nuclei are very common in cancers. They are also common in crown gall.

Cancers in addition to the malignant cells contain a stroma or framework of connective tissue and a system of blood vessels and lymph channels by means of which they are nourished, but the blood flow in these vessels is not controlled by any vasomotor nervous system. Ordinarily cancers do not contain any nerves, the associated pain being due to pressure on outside nerves.

All of these tumors are imperfectly provided with blood vessels and are subject to early decay, the resulting cavities, or open wounds, being exposed to various harmful secondary infections. In early stages of growth these tumors are purely local and may be removed surgically with good prospect that they will not return. In late stages these tumors exert a markedly detrimental effect on the whole body, which is visible as atrophy, anemia and cancerous cachexia, and surgical interference is then of little or no avail.

The daughter tumors are produced from the mother tumor in several ways, *i. e.,* by contact of a diseased area with a healthy area, as for example, by tongue against lips, or cheek against jaw; by invasive growth, *i. e.,* tumor-strands out of which the secondary tumors develop as in cancer of the breast; by motile (creeping) tumor cells; or finally, by cells or fragments dislodged by the blood stream or the lymph stream and carried to distant parts, where they multiply. The carcinomas usually invade by way of the lymphatics; the sarcomas and the embryomas, by way of the blood-vessels. When a tumor-strand can be traced from the daughter tumors back to the mother tumor they are called *invasive growths;* when no such connecting link is

visible they are called *metastatic* (or shifting) *growths*. Some modern writers, however, use the word metastasis for a daughter tumor of any origin.

As I have said, nothing is known respecting the cause of these human tumors and the great majority of cancer workers have come to the conclusion (which I believe is erroneous) that they can not be due to parasites.

It is well here to pass in review some of the objections to a parasitic theory of cancer: (1) Because many authors of distinguished reputation (Ribbert, for example) maintain that they are insuperable; (2) because so long as they are not met various persons will be discouraged from undertaking active researches designed to uncover the parasite; and (3) because, finally, if I can convince you that crown gall is a cancer, you will then be ready to admit that what requires a schizomycete for its production in the plant is not likely to be produced in any very different way in man and animals. Here then are some of the objections, and I will meet them as fairly as I can.

1. Nothing definite in the way of a parasite has been made out by use of the microscope. *Answer:* This is admitted, but it proves nothing. If we exclude the Negri bodies, still in dispute, the same is true for rabies. And in cancer we have the Plimmer bodies and other cell-inclusions of a doubtful nature, some of which may be bacterial or protozoan. The etiology of crown gall would still be in doubt if we had depended solely on the microscope, for no ordinary staining will demonstrate a bacterium in the cells, and yet it is there. For the final analysis recourse must be had to cultures and inoculations. There are then some problems in pathology which never can be solved simply by the use of the microscope.

2. From cancer no parasite has been isolated in spite of diligent bacteriological search. Innumerable cultures have been made and many inoculations and all have failed. *Answer:* The same is true of yellow fever. No parasite has been found. Until recently the same was true of syphilis. Ten years ago it was true of crown gall. There may be some very special reason (as in crown gall, or in certain types of arthritis) why isolations have failed; or the right organism may have been isolated and inoculations may have failed simply because the inoculated animals were *normal, i. e.*, fully protected by their leucocytes and therefore not susceptible. We must, I think, conceive of cancer as developing only in a weakened, unprotected condition of the body. The more or less ready growth of grafted cancer in certain animals offers no real contradiction because here the conditions are somewhat different from what they would be in case of a naked bacterial inoculation, because the grafted cancer cells are autochthonous cells and are introduced into the mouse or other experimental animal in a considerable compact mass, the inner cells shielded by the outer ones and all developing a kind of protective aura under the influence of which union with the host tissues takes place and the cancerous growth continues.

3. Heredity is a sufficient explanation. *Answer:* The same thing was said repeatedly of tuberculosis prior to 1884. Now we see that heredity furnished the canvas but could not paint the picture. Miss Maude Slye's work on heredity of cancer in mice is astonishing and praiseworthy, but I do not feel sure that a similar picture could not be obtained by breeding together tuberculous animals, indeed I am quite certain that the results of such experiments would be a vastly increased number of tubercular animals, and if we knew no more about the cause of tuberculosis than we do about the

cause of cancer, the interpretation of the results would be entirely wrong, *i. e.*, they would be ascribed wholly to heredity, whereas we know that two factors are involved: (1) heredity; (2) infection. I do not think Miss Slye has established the fact that cancer follows Mendel's law.

4. There is no need to postulate any parasite, since the cancer cell itself is the all-sufficient parasite and no cancers can be produced in the absence of this cell. *Answer:* It is strange that the authors of this statement, which has been dinned into us for a generation, can not see that it is no answer at all, but only a makeshift. As well say: Tetanus is due to tetanin. Certainly, we all admit this, but what originates the tetanin? and what originates the cancer cell? Moreover, loath as these objectors are to admit it, cancers (sarcomas) in barnyard fowls can now be induced by cancerous material all the cells of which have been removed by *filtration,* or have been killed by *heat,* by *freezing,* or by *drying* (Rous). And how should anemias and cachexias arise as the simple result of the proliferation of body cells? In other diseases they are the direct result of bacterial or protozoan multiplication in the body. In this connection reflect for a moment on what goes on in streptococcal arthritis, in persistent agues, or in yellow fever and in blackwater fever where the red blood corpuscles are destroyed wholesale. Even pernicious anemia will, I believe, be traced eventually to a blood-destroying parasite. All that we yet know definitely concerning the natural occurrence of anemias (I am purposely excluding surgical ones) is that in certain diseases they are due to blood-destroying parasites, and it is not going very far afield to assume that anemia is so produced in cancer.

5. The idea of a parasite is too complex. We know that we can graft cancer only within the narrowest limits, and also that within the same species each sort of cancer reproduces its own kind. We must therefore postulate not only as many different cancer parasites as there are animals subject to cancer, and that is probably every kind of animal, but also a parasite for every special kind of cancer in each particular animal, which is a *reductio ad absurdum. Answer:* This is a molehill magnified into a mountain—an unsubstantiated and unwarranted hypothesis! The history of science is full of such objections. Against the plainest evidence it is always easy for certain types of mind to raise objections, which then generally are left to some one else laboriously to test out experimentally, whereupon they vanish into thin air, the objections not having been well grounded. Some people are good *only* as objectors! They can not do anything concrete. It is less than twenty years since certain theoretical Germans were saying: There are no bacterial diseases of plants and can not be any, for the reasons we have given. Yet the experimental method has demonstrated the existence of nearly a hundred. In science, no theory is worth a picayune that does not have an experimental basis under it! There have been at least thirty so-called explanations of cancer origin propounded during the last half century, not one of which really explains or has any experimental basis under it. Cohnheim's theory is one of these; Ribbert's is another.

From the behavior of the cells of one species when grafted on another species we can postulate nothing as to what a naked microorganism would do under the same circumstances. As a matter of fact, plants also can not be grafted widely, yet the crown-gall organism is widely inoculable. *Moreover, it yields one result when inoculated into one set of tissues and a different result when inoculated into another set of*

tissues. In malignant neoplasms in man, and the lower animals, why then may we not assume for experimental purposes an intracellular parasite capable of producing sarcoma when infecting connective tissue cells and other types of tumor when infecting other tissues—each tissue presumptively developing according to its own type? Theoretically I can see no objection to this view, and actually we have this very thing occurring in crown gall.

6. Parasites destroy cells. They do not cause them to proliferate, and calling cancer a cell-symbiosis does not help matters. *Answer:* The world progresses and new knowledge modifies or supplants the old. Menetrier, of Paris, without knowing anything about our experimental work on crown gall, and being very sceptical as to the parasitic origin of cancer, saw clearly in 1908 (and so stated in his book) that there was no objection theoretically to assuming that in cancer there might be a parasite which did not destroy cells, but continually stimulated them to divide, only he said: What is the use of speculating, since nobody has shown any concrete example? This may have been true of that time, but it is no longer true, since there is just such a cell-parasite, or cell-symbiont, in crown gall.

7. In cancer, portions of the body grow in places where they should not, having come to the place by growth-extension from the primary tumor or having been transported there by a blood stream or a lymph stream. Nothing like this occurs in any parasitic disease. *Answer:* Formerly this statement corresponded to our knowledge, but now it does not, because just this thing occurs in the parasitic plant disease of which I am speaking, viz., invasion or growth-extension from a primary tumor resulting in the occurrence of secondary tumors in what previously were normal parts of the plant!

8. Direct stimulation of cell growth by a parasite is an unknown occurrence in biology. In all cases in which parasites are found within cells the effect is the destruction either of the parasite or of the cell. *Answer:* Antiquated information. True of many things, but not of *all*. Theoretically a third possibility exists, and actually we have it in crown gall. Here the parasitized cells are not destroyed, neither are all of the bacteria within them killed, but only most of them. There is a very delicate balance between the two, which results not in death of the host cells, but in an increased tendency to cell-division, a tendency strong enough to overcome the physiological control of the plant. When death results it is not due to the direct action of the bacteria, but to other factors, *e. g.*, nutritional defects, and secondary parasitisms.

9. Since cell proliferation in tumors is similar to cell proliferation under normal conditions, the assumption of a parasite to explain it is quite unnecessary, and makes an explanation of tumor-growth more difficult. *Answer:* Similar is not necessarily *the same.* Conclusions drawn from cultures *in vitro* do not necessarily apply to growth within the body. Cell-proliferation of tumor tissues in the body is similar, of course, to normal cell proliferation, *but with a difference,* namely, in the tumor there is an *unknown something,* which compels these cells to proliferate *in opposition to the needs of the body and in spite of the physiological body control.* Surely something very foreign to the body is required to explain the *undifferentiation,* anaplasia we call it, following von Hansemann, and the *excessive vegetative force* of the cancer cells. Moreover, so far as it is able to do so, the body treats individual cancer cells, or groups of cancer cells (metastatic fragments) exactly like parasites, that is, it envelops them in a blood clot and destroys them. In cancer, therefore, considering

what takes place in crown gall, I think we are warranted in searching for an intracellular parasite, probably some common organism, as the unknown factor, necessary to satisfy the equation and explain the phenomena. Moreover, I fail to see how the assumption of a parasite makes the explanation of tumor growth "more difficult." These objectors are here dealing with one of their many *assumptions* while I am dealing with *a fact*. I insert my infected needle and I obtain a tumor. I insert a sterile needle and the wound heals normally. Into one branch of a young Paris daisy I set my infected needle 50 times and obtained 50 tumors; at the same time into the twin branch I set a sterile needle 50 times and obtained no tumors whatsoever, but only a normal healing of the wounds. Cell proliferation *per se* in no way explains cancer. Normal cells, also, judging from the way they behave in blood serum under the microscope, must often proliferate into the plasma of the body, but such wandering cells are promptly disposed of in accordance with the law of antagonism or of physiological control, or whatever you please to call it. I mean the action of the body as a whole. Otherwise, we should have occurring continually in the body what takes place when normal tissues are cultivated *in vitro*, that is, a copious cell proliferation, which would be disastrous. This we do have in cancer, but since cancer develops in opposition to all the compelling forces of the animal body it must be owing to a profound disturbance of the normal (interior) activities of the cells involved. What is so likely as a microorganism to produce this cell disturbance leading to the formation of a tumor? Especially what, since in the plant we know that one does produce just that?

10. Cancers are due to long-continued inflammatory conditions. They begin in bruises, in old (unhealed) wounds, X-ray burns, charcoal stove burns (Kangri cancer), and various irritations and injuries incident to special trades (chimney sweeps' cancer, paraffin workers' cancer, etc.). *Answer:* The second statement is admitted. They begin in all of these places. The first statement is a *non sequitur*, a *post hoc ergo propter hoc* argument. Wounds are often infected with visible parasites, why not sometimes with invisible ones? Not all irritations end in cancers. Of two long-continued irritations one may become malignant and the other not. This is wholly inexplicable on the theory of simple irritation, but readily interpreted if we assume that cancer is due to a special and unusual kind of parasite, certain long-continued irritations having paved the way for a peculiar infection by having reduced the resistance of the body.

11. Surgeons, nurses and relatives do not contract cancer. It therefore does not behave like a communicable disease. *Answer:* Neither does malarial fever; neither does arthritis; neither does leprosy; and, finally, neither does crown gall. We must recognize that in nature there are all grades of parasitism and must be prepared to welcome forms not hitherto recognized. In pathology, as everywhere else, the open mind is after all the best asset. Closed and crystallized minds are of no further use in the world! Certainly cancer is not an acute infection, and no one regards it as such. It may be due, however, to a parasite, visible or invisible as the case may be, *some feeble parasite against which the normal body is fully protected,* some common organism, living saprophytically on the body, or in the soil, able only to infect a depleted body, and destructive only when through wounds (very slight ones, it may be) it has penetrated into the interior of certain cells, which neither kill it nor are killed by it, but

where it depresses functional activity while at the same time enormously stimulating vegetative activity. In the present state of our knowledge no one can say that this is an untenable working hypothesis. Indeed the probabilities in favor of such a view are much stronger to-day than they were five years ago, when I first discovered the cancerous nature of crown gall and began to formulate my ideas.

12. We might, possibly, concede sarcomas to be due to a parasite, but not carcinomas, and certainly not embryomas, yet whoever proposes a parasitic theory of cancer must not only demonstrate his parasite but with it must account for all of these diverse forms, and especially for embryomas, since they are the crux of the whole situation.[3] *Answer:* This is admitted. All of these forms hang together, and the claim is now made that embryonal teratomas and gland proliferations can be induced with the same schizomycete previously used to produce sarcomas. As a negation it is of no consequence whatever to say that I have only produced them in *plants,* because, little as it is yet recognized, plants are better adapted than animals to certain purposes of cancer research. In due time and in the same way, let no one doubt, they will also be produced in animals. *Whatever else may be denied, the bold fact now stands out demonstrably that all the leading types of cancerous proliferation can be produced in plants with one microorganism.* If any one doubts it, let him repeat my experiments.

13. But this hypothesis of the origin of cancers, and especially of embryonal teratomas upsets Cohnheim's theory of "cell-rests." *Answer:* It does, beyond doubt, very completely. But there is no use of making a fetish of Cohnheim's theory. It is, after all, *only a theory.* It seemed once to furnish the basis for an explanation of cancer origin, but no one was ever able to build a superstructure on it, for no one can explain why some "cell-rests" grow into cancers while others, and by far the larger number, remain dormant. We shall simply have to write *Hic jacet* over Cohnheim's theory. It serves well enough for monsters and for typical teratoids, but it does not explain cancers.

14. Plants are so unlike animals that no comparison can be drawn from diseases of the one group to those of the other group. *Answer:* On the contrary, fundamentally, plants and animals are very much alike. I mean the resemblances are much more basic than the differences. The latter, very conspicuous to the eye, may be regarded as differences of degree rather than of kind, corresponding to differences in function. Such an objection could never be raised by a biologist. It shows perhaps better than any other argument how great is the need of injecting biological concepts into cancer research. The cancer problem would have been settled long ago, I believe, had it been approached commonly from this angle rather than from that of pure morphology. Of many of the lower forms of life it is still very difficult to say whether they are plants or animals, of the whole group of bacteria, for example; and for the primitive, doubtful forms of life you will recall that Haeckel created the special kingdom of Protista. To my mind a fundamental unity runs through all living things from the lowest to the highest, like the gold thread through a tapestry! For one thing, all are *alive;* all possessed of that unstable equilibrium of forces expressed by the words *growth* and *decay.* These phenom-

[3] Gerade in diesem Punkt scheint mir die interessanteste und wichtigste Beziehung der Teratomen zu den anderen Geschwülsten zu liegen, dasz wir in den Teratomen eine Gruppe von Produkten vor uns haben, in welcher sich die Hauptfragen der Geschwulstlehre wie in einen Brennpunkt vereinigen (Borst).

ena are the properties of a substance called *protoplasm*. In both plants and animals this substance is organized into the form of cells. In both, usually, it is the outer protoplasmic membrane that controls the passage of *ions*, the disassociated electrically charged elements of water and other compounds. The same wonderful process of cell-multiplication by *mitosis* occurs in both plants and animals. In both, except in the lowest forms, these cells are organized into *tissues*, with *division of labor*. In both there is a *sexual method of reproduction*. Plants, indeed, propagate also *non-sexually by budding*, but so do many of the lower animals. In many plants there is *regeneration* when parts are cut away, but so there is in a great variety of animals. Even their foods are not different. It is true, the plant differs decidedly from the animal in possessing an apparatus for elaborating inorganic substances into starch, sugar and proteids which the animal consumes, but it makes these substances for its own use, not for the animal. It is sometimes assumed that the inorganic substances, of earth, air and water, are the food of the plant, but such is not the case. The plant depends for its growth on the same nutrient substances as the herbivorous animals, viz., on starch, sugar and proteids, which it has stored in every seed and under every growing bud. The phenomena of birth, growth and decay are essentially the same in plants and in animals; but corresponding to higher development, the animal has many special organs either wanting altogether in the plant, or greatly simplified; it also has flexible cell-walls while the plant has rigid cell-walls; but both plants and animals *respire;* both *assimilate* food substance, and *oxidize* them with resultant work; both require about the same amount of *water and mineral salts;* both have a *circulation* of fluids; and both *secrete* and *excrete* a variety of substances, acid, alkaline and neutral. The *response to stimuli*, such as gravity, heat, light, radium, X-ray, electricity and poisons, is much the same in both groups. In irritable response plants and animals both obey Weber's law (called also Fechner's law and the psycho-physic law), that is, to increase a response in an arithmetical ratio the stimulus must be applied in a geometrical ratio. There is a suggestion, even, of a nervous system in plants since stimuli are passed along certain channels to distant organs and the movement can be slowed down by cold, increased by heat or inhibited by poisons applied midway, the response, according to Bose, being not simply hydro-mechanical. Even the idea of locomotion does not distinguish animals from plants. Many of the lower animals are rooted fast, while many of the lower plants have swimming organs and are actively motile. Moreover, all of the higher plants change position more or less; all are sensitive; all show rhythmic movements. Finally, the *intimate cell-chemistry* of the two groups (production of digestive enzymes, amino acids, etc.), so far as known, is much alike. There is no *a priori* reason, therefore, why a special stimulus to cell division in plants might not prove to be of the highest interest to students of cancer in man and the lower animals. It is a matter to be taken up like any other and tested out. Researches on crown gall should have been undertaken long ago in every cancer laboratory in the world and would have been had we not unfortunately discovered a parasite. That killed the whole subject in the eyes of the orthodox! Not having found a parasite themselves, they will not believe that any one else can do it, or that there is one; and this in spite of the fact that the history of parasitic diseases from Pasteur's time down shows clearly

enough that the folly of one generation has been the wisdom of the next!

Von Hansemann has said[4] that crown gall has nothing in common with cancer except its name (Krebs). I am quite willing to let specialists weigh my evidence and decide for themselves, if only they will wake up and begin to do so! not simply ignore the whole subject because it comes to them from an unusual quarter, and is "too botanical," as another German editor said in refusing one of my papers.

In his "Principles of Pathology"[5] Doctor Adami gives the following as the characteristics of the atypical (malignant) tumors: (1) Vegetative (embryonic) character of the tumor cells; (2) rapidity of growth; (3) peripheral extension, lack of capsule and infiltration of the surrounding tissues; (4) tendency to develop metastases; (5) tendency to central degenerative changes; (6) liability to recurrence after removal; (7) cachexia; (8) anemia. All of these occur in crown gall except 4 and 8. There is nothing in the plant corresponding to blood, and the rigid cell-wall of the plant prevents metastasis in the true sense of that word. But if we use metastasis in Ribbert's loose way, then metastasis also occurs in crown gall.

One of the striking things about cancer and one separating it off sharply from all other animal diseases, is the fact that the secondary tumors are not granulomatous proliferations. That is, the secondary tumors are not a growth-response of local tissues to an irritation, and hence are not comparable to the protective granulations formed in the healing of a wound or in such a disease as tuberculosis, but they are due to the migration from the initial tumor either of infected cells or of deteriorated cells which continually reproduce their own kind to the detriment of all others. The cancer cell is a lawless entity, different in its tendencies and capabilities from any other cell of the body, and so far as we know, it always reproduces its kind, the daughter cells being cancer cells and not normal cells. Why this is so is wholly unknown in human and animal pathology, but that it is so admits of no doubt whatever. To illustrate: If medical men were able to reach into the center of tubercle nodules or syphilitic nodules in the human body, and kill the nest of pathogenic bacteria in the one case and of pathogenic protozoa in the other case, without injuring the unparasitized barrier cells forming the periphery of these nodules, then these cells would be immediately destroyed and removed from the body as no longer of use, or else would behave once more as normal body cells (scar tissue). In cancer, on the contrary, as every surgeon knows, if any cancer cells are left after an operation—even the least number—they are likely to reproduce their evil kind, in which case another tumor results either in the old locality or in some other part of the body. In other words, the outermost cancer cells are not barricades erected by the body to prevent further encroachments of the enemy, but are self-multiplying outposts of the enemy himself. However, this does not militate against the belief that some of the elements in a malignant tumor are harmless ones.

Very few laymen, I believe, have any clear conception of the exact mechanism of the cancerous process, and not a few physicians also seem to be ignorant of it. Cancers are the result of the multiplication in the body of certain body cells which have become abnormal and dangerous to the rest of the body, or as we say "cancerous," a single cell or a few cells to begin with, then

[4] *Zeitschrift für Krebsforschung*, 12te Bd., 1913, p. 146.

[5] Vol. I., p. 671.

many. Whether infected or only degenerate, these cells retain their hereditary tendencies, that is, liver cells to reproduce liver; brain cells, brain; connective tissue cells, connective tissue; and so on; but all of them while deriving nourishment from the body have become more or less emancipated from body control and exercise their freedom by an unlimited and hasty multiplication very destructive to the other tissues of the body. They reproduce their kind first in the primary tumor and later in secondary tumors. I can make this plainer perhaps by another illustration. Following tuberculosis of the lungs there sometimes occurs blood-infection and a generalized tuberculosis of every organ in the body, but in such cases the nodules wherever they arise are due to local bacterial irritation, and are always built up out of local tissues, liver tissue in the liver, spleen tissue in the spleen, and so on. In cancer, on the contrary, it is the cancer cell which migrates with all its hereditary tendencies and the secondary tumor, therefore, reproduces more or less perfectly (or imperfectly) the hereditary cell complex of the primary tumor, so that the trained pathologist after studying sections of a cancer can usually (but not always) decide whether it is primary in the organ under examination, or secondary, and if secondary, then in what other organ the primary tumor is to be sought. For example, if a primary cancer occurs in the liver and there are metastases to the lungs the *lung tumors will contain liver cells;* so if a primary cancer occurs in the stomach and there is metastasis to the liver, the liver tumor will not be formed out of liver cells *but out of stomach cells.* It is a very striking thing to see under the microscope, particularly in a well-stained section, a nest of malignant glandular stomach cells in the midst of a piece of liver. I do not know that it has been actually proved but undoubtedly such a liver tumor must have the power of secreting pepsin or at least of mucin, just as we know that metastases from a primary liver tumor into other organs may retain the power of secreting bile.

I have now come to another way in which these plant tumors resemble cancer in man and the lower animals, viz., in the striking fact that as in animals the secondary tumors reproduce the structure of the primary tumor. Thus, when a primary tumor is induced on a daisy stem by inoculation, deep-seated secondary tumors, developed from parenchymatic tumor-strands, often arise in the leaves and these tumors convert the unilateral leaf or some portion of it into the concentric closed structure of a stem. (Slides shown.)

Having now reviewed my older discoveries,[6] I come to details of more recent ones also bearing directly, I believe, on the etiology of cancer.

I have referred to the rapid growth and early decay of cancers in men and to the common occurrence of atrophy and cachexia in connection with such tumors. Similar phenomena occur in the plant. I show you three slides from photographs of galled sugar beets. They were grown in different years (1907, 1913 and 1916) but each showed the same thing, viz., sound control plants and dwarfed, sickly (yellow) and dying inoculated plants. Each inoculated plant bore a tumor larger than itself and the time from inoculation to date of the photograph varied from 2½ to 4⅕ months. This year I have obtained the same results on ornamental (white flowered) tobacco. At the end of five months all of these inoculated tobaccoes are dead or dying from large tumors of the crown, whereas the control plants are healthy, many times larger

[6] See this journal, N. S., Vol. XXXV., p. 161.

and now in blossom. To get such prompt, disastrous results, the inoculation must be fairly early in the life of the plant and near the growing point.

Secondary infections due to other organisms are also as common and as disastrous in crown gall as in cancer in man. Just now in the hothouses we have striking examples of it on the Paris daisy and I will show you a few slides. (Slides.) These secondary infections may be either fungous or bacterial.

Third, let me show you some examples of *infiltration*, taken from sunflower heads inoculated last year. The first three slides show hard greenish gray vascular tumors which have developed from a few needle pricks made into the extremely vascular thin layer which bears the seeds. The one shown in vertical section is from the middle of the flower disk and it has grown downward in the white pith for a distance of 4 inches. It lies in the pith but has not developed out of pith. The fourth slide from another tumor shows cancerous cells and vessels of the supporting stroma pushing out into the sound tissues much as roots do into a fertile soil. The fifth slide is from the cortical part of a teratoma on *Pelargonium*. Here the small-celled blastomous tissue has crowded in between coarse cells of the cortex.

Next to be considered are examples of atypical blastomous tissue taken from different parts of the same tumor (a young deep inoculation into the stem of a Paris daisy). In the first slide, at the left, is a part of the supporting stroma (cortex cells); the right side shows round cells of the same type that have become cancerous, *i. e.*, much smaller, more embryonic, rapidly proliferating, large-nucleate and deep-staining cells which have lost their polarity. The second slide shows spindle-shaped blastomous cells from the outer part of the same tumor. This tumor is the ordinary rough gall of the daisy stem, which is a sarcoma as near as the plant can make one, that is, a sarcoma minus the intercellular fibrils which are wanting in plants.

Now let us consider how plastic the living tissues can be when they are brought under a cancer stimulus. I show you photomicrographs of tumors (atypical hyperplasias) produced by inoculating the crown-gall organism into the extreme outer bark (living cortex) of young stems of Paris daisy, the inoculated cells being ordinary cortex cells. These tumor cells which conceal the bacteria (there are none in the intercellular spaces) have become more embryonic than the tissue out of which they have grown. This is shown by their size ($\frac{1}{20}$ that of the cells from which they have developed), their large nuclei and their avidity for stains, as well as by the peculiar way in which they fix the stains. It is also shown by the fact that they can produce vessels in their midst (trachei) whereas the uninjured cortex never produces vessels. The embryonic tissues of the plant, however, have this vessel-producing power. In a word, these tumor cells have become more embryonic than the tissue out of which they have developed and have lost their polarity, and this is exactly what occurs in cancer in man, as I shall show you. I have produced these superficial fine-celled hyperplasias out of coarse-celled cortex, not once, but a number of times, and in several different kinds of plants.

Thus far I have spoken only of one type of tumor, the common crown gall. Until this winter (if we except hairy root) I did not know of the existence of other types. Now I believe from what I have seen that all the leading types of cancer, viz., (1) sarcoma, (2) carcinoma, (3) mixed tumors and (4) embryomas, occur in plants and that all are due to one and the same organ-

ism. I certainly have abundant material of the end terms (Numbers 1 and 4), and enough of 2 and 3 to convince myself, if not others.

The "further evidence" alluded to in the title of this paper relates more especially to the embryomas and consists of the discovery of an entirely new type of plant tumor due to the crown-gall organism, in which tumor there are not only ordinary cancerous cells of the common crown-gall type but also entire young shoots or jumbled and fused fragments of leafy shoots and of other young organs, thus making the tumor correspond to the highest type of animal cancer, in which in addition to the blastomous element there are fragments of various fetal tissues, sometimes representing many organs of the body. This is, I believe, the first time this type of tumor has been produced experimentally, and it has been done with the bacterial organism cultured from an ordinary rough crown gall of the simpler, well-known type. It was first done by inoculating the leaf axils of growing plants, *i. e.*, the vicinity of dormant buds, in other words, centers containing totipotent cells. Some of these strange tumors have produced daughter tumors in other parts of the stem and in leaves and, as in the embryonal teratomata in man, a portion of these secondary tumors have the full structure of the primary tumor.

I have also produced these teratoid tumors in parts of plants where no totipotent cells are known to exist, but only young plastic cells normal to the parts and hitherto supposed to be able to produce only one kind of organ. This will be plainer if I say that by needle pricks introducing the bacteria locally I can now produce atypical teratoid tumors in internodes and in the middle of leaves, an astonishing discovery, and one bound, I believe, to revolutionize our views as to the origin of these tumors in man. I do not here deny that totipotent cells, hitherto unsuspected, occur in the places I have inoculated, indeed they must so occur, but I only cast doubt on their abnormal occurrence in such places, *i. e.*, as the result of early embryonic dislocations.

The belief that I have also produced "mixed tumors," that is, tumors containing distinct types of tumor cells originating from different layers of the plant, rests on stained sections of tumors from several different kinds of plants. The evidence here is not as complete as in the case of the embryonal teratoma, and I am still experimenting. What I think I have in one part of the tumor is sarcoma originating from the deeper connective tissue layers and in another part of the tumor carcinoma derived from the skin and glands of the plant. However this may be, it is now beyond question that two very distinct types of plant tumor (sarcoma and embryonal teratoma) corresponding to similar types in man, as nearly as plant tissues are able, can now be produced by bacterial inoculations, *using the same organism.* To get one type of tumor I inoculate one set of tissues, and to get the other type, another set of tissues.

Coming to the details of my newer studies, I shall first take up the question of the possible existence of carcinoma in plants, the slides I shall show you being from photomicrographs of what I consider to be "mixed tumors." All are due to pure-culture inoculations, but they show a diverse internal structure suggestive of a mixture of epithelioma (skin cancer) and sarcoma (connective tissue cancer). There is still, perhaps, some doubt as to the interpretation of these facts, so that I speak only with reserve.

The first slide I show you is from a teratoma on the common *Pelargonium* or house

geranium, but in this connection I invite your attention only to a small portion of its surface (teratoid part) where strange phenomena are in progress, quite like what often occurs in the epithelium of human teratoids. Here is a compact, small, surface tumor showing subepidermal erosion, an effort on the part of the plant to protect itself. Its deeper tissues fuse into those of the epidermis in such a way as to suggest that they have originated from the latter, *i. e.*, there are no epidermal and subepidermal differences, although these differences are conspicuous in the normal plant and also in other parts of the teratoma. In this late stage of development it is impossible to tell what may have been the origin of these queer tumors, but what appear to be much earlier stages of the tumor are visible in several places, especially on their margins, and these places exhibit, or seem to exhibit, all stages of transition between the normal one-layered faint-staining columnar epidermis (equivalent to an epithelium), and a several-layered, large nucleate, loosely arranged, deep-staining tissue, the cells of which are rounded or angular and have lost their polarity, that is, their orderly relation to their fellows. Now this is exactly what takes place in early stages of carcinoma. For instance, below the one-layered epithelium in glandular tissues of the breast, of the stomach, etc., irregularly placed, large, deep-staining, rapidly proliferating cells make their appearance as shown on the next slide, which is from a cancer of the lung. This kind of proliferation is recognized as the beginning of a malignant tumor, and surgeons base their operations on its presence or absence. If, in the breast, let us say, this displacement of cells is present, then the surgeon does a major operation, but if it is not present, then he is content with having removed only the local nodule. These surface tumors on the geranium were accidental discoveries, but I have now begun a systematic inoculation of the skins of plants to see what I can get.

I have what I believe to be the same phenomenon (a mixed tumor) on tobacco. This tumor I produced out of young cortex in 1907, but it has been properly stained and critically studied only recently. Its outer part consists of blastomous cells quite different in shape and staining capacity from the cells of its inner part. The outer cells are more or less compact and angular and the protoplasmic contents stains uniformly. The inner cells are round, more loosely arranged and stain like the ordinary sarcoma cells of this tumor. In connection with the last slide I would also call special attention to the evidence it shows of the appositional transformation of normal cells into cancer cells (atypical blastomous cells). I refer to the band of tissue lying between the normal cortex on the right (out of which the tumor has developed), and the fine-celled hyperplasia on the left. These 10 or 12 rows of cells, bordering the tumor, have the same arrangement as the tumor cells and stain deeply like those of the tumor, but are several times as large. Occasionally an unchanged cortex cell is buried in their midst. They are, I believe, a transition from the normal tissue into cancerous tissue.[7] The same phenomenon has been seen in human cancers by several good observers and there can be no doubt as to its occurrence.

Finally, from shallow bacterial inoculations done on the glands of *Ricinus* last winter I have also obtained what appears to me to be satisfactory evidence of glandular proliferations, *i. e.*, rapid multiplication of the surface layer of cells with loss of form and polarity and entrance into the

[7] See *The Journal of Cancer Research*, April, 1916, Pl. XXIII., Fig. 78.

subepidermal region as an invasive hyperplasia. The punctures were deep enough, however, to have infected the subglandular connective tissue which is also proliferating. The sections were cut at the end of 27 days and show transitions from a columnar (glandular) epidermis into an irregular, angular-celled, large nucleate, deep-staining mass of rapidly multiplying atypical cells corresponding to an epithelioma (slides). The shape of these cells is exactly that of proliferating epidermal cells from my 1/100 mm. deep 72-hour inoculations on tobacco stems. I have not yet obtained metastases from such surface growths, but I am only now beginning my studies of skin and gland proliferation and there is much to learn.

We now come to embryomas. Before describing the atypical teratoid tumors I wish to make some general remarks. Conceiving human and animal cancer to be due to a parasite, I have been greatly interested for the past ten years to see to what extent the phenomena of such cancers, the cause of which is unknown, can be paralleled by crown gall phenomena the cause of which is an intracellular schizomycete. By discovery of a tumor-strand and of stem structure in leaf tumors (in 1911) my interest received a tremendous accession from which it had not yet recovered when the newer discoveries of this winter converted it into a white heat! I am now persuaded that the solution of the whole cancer problem lies in a study of these plant tumors. At least they must now be studied until the matter is definitely settled, pro or con.

If cancer is due to a microorganism, bacterial or other, we are not obliged *theoretically* to conceive of all such new growths as due to one and the same parasite, nor, indeed, on first thought, is such the more probable hypothesis. The first thought is that probably there must be as many parasites as there are kinds of tumors, yet certainly, on further reflection, the mere cell differences between a sarcoma, let us say, and a carcinoma do not necessarily involve the conception of two parasites. The two tumors can be explained theoretically just as well by the postulate of one parasite, and in the light of our researches on crown gall much better *by one*. If the tissue response depends on the kind of cell or cells first infected, as apparently it must, on the assumption of a parasitic origin, then, of course if connective tissue cells only are involved, we shall have sarcoma; if gland cells only are invaded we shall have carcinoma; or if both, then a tumor containing both types of cancer. Whichever cell was first invaded (the bacteria being imprisoned) would be likely to continue its proliferation as a tumor of a pure type, but other elements might eventually become infected by a surgical operation, or otherwise, *e. g.*, a sarcoma might follow a carcinoma as in some mouse tumors, and also in man, the connective tissue stroma becoming infected.

I now think the human embryonal teratomata are cancerous not only potentially, but actually from the beginning. Many of them have been recognized to be so on removal, and in the remainder the stimulating blastomous portion may have remained undiscovered owing to its relatively small size, as was the case in hairy root of the apple (and every particle of such a tumor would have to be sectioned and studied before one could deny it), or it may have receded during the rapid development of the non-blastomous purely teratoid portions. All of them, whether it be assumed that they have developed from "cell-rests" or parthenogenetically, are, I believe, due to the stimulus of a microorganism, but not necessarily of a schizomycete, since other orders of parasites may,

conceivably, give rise to the same chemical and physical stimulus.

Wilms in his book on "Die Mischgeschwülste" (Heft 3, Leipzig, 1902, p. 242), if I understand him correctly, considers the blastomous portions of embryoid tumors to be of a secondary nature, as do other writers, but in this assumption they are probably wrong.

To the statements of these authors claiming the cancerous element to be secondary, may be replied: The same could be said of the shoot-producing tumors on *Pelargonium* and on tobacco did we not know experimentally that it is actually the infected tumor tissue which is the earlier and which has stimulated the normal tissues to develop. Moreover, which tissue *is* the earlier is a matter that can not be determined by mere observation of sections (Betrachtung des Wachstums—Wilms), but one to be worked out experimentally.

To condense results, I may say that during the past winter I have discovered that when the crown-gall organism (*Bacterium tumefaciens*) is introduced into the vicinity of dormant buds on growing plants atypical teratoid tumors are produced quite regularly. I have obtained these in *Pelargonium,* tobacco (2 species), tomato, *Citrus, Ricinus,* etc. Apparently what happens is this: The bud anlage are torn into fragments by the rapidly growing tumor and these fragments are variously distributed and oriented in the tumor where under the stimulus of the parasite they grow into abortive organs variously fused and oriented, some on the surface of the tumor, others in its depths. Surface fasciation occurs. Also in the depths of the tumors fragments of organs occur, lined by membranes bearing trichomes (hairs) and lying upside down and variously oriented and combined. The flower shoots and leaf shoots on the surface of such tumors vary greatly in number and in size, often they are the merest abortions and in that case there may be a hundred or more of them (leafy shoots or flower shoots) on a single tumor, especially on the *Pelargonium.* Even the largest and best developed surface shoots if they arise out of the tumor tissue and not from its vicinity are feebly vascularized and become yellow and dry up within a few months and often before the tumor itself decays. Such shoots never come to maturity. Immature fragments of ovaries and of anthers also occur on the surface and in the depths of such tumors.

These teratomas when produced in leaf axils on the castor oil plant reach a large size and perish quickly, *i. e.,* often within 2 months. Frequently in this plant the neighboring glands on the base of the leaf stalk are also invaded (within 2 or 3 weeks) and greatly enlarged. This is one of the striking results on *Ricinus* to which I would call special attention, since it is very suggestive of what often occurs in cancer in man, that is, of the malignant enlargement of lymph glands in the vicinity of a cancer. Following inoculations on the middle part of the leaf-blade of *Ricinus* I have also traced a parenchymatic tumor-strand down the petiole a distance of 11 cm. This was nearly circular in cross-section, large enough to be visible to the naked eye and composed of parenchyma cells. Corresponding to this were swellings on the surface of the petiole and bulging into the petiole cavity, but no ruptured tumors. No teratoids were formed on the *Ricinus* leaves.

Daughter tumors are produced freely on tobacco if the inoculations are made early enough, and these often reproduce all the teratoid elements of the primary tumor, *e. g.,* daughter tumors 10 inches away from the primary tumor may bear leafy shoots. These secondary tumors, which have been seen both in stems and in leaves, are con-

nected with the primary tumor by a tumor-strand which is lodged in the outer cortex and is vascular, *i. e.*, has the structure of a diminutive stem (stele).

What is still more astonishing, I find that I can produce these teratomas in the leaves of tobacco plants, where no dormant buds are known to exist.[8] To get these results the leaves must be fairly young, *i. e.*, plastic. They will then produce tumors where they are inoculated (needle-pricked) and many of these tumors will be covered with leafy shoots (tobacco plants in miniature). I have obtained seven such teratomas from the blade of a single leaf, and twenty-seven from the leaves of a single plant—too many to be due to Cohnheim's "cell-rests." They must have originated, I think, from groups of plastic (totipotent) cells normal to the inoculated parts of the leaves and probably also present in many uninoculated parts of such leaves, if not in all parts.

How, then, can these phenomena be explained? The teratoids I have obtained being essentially like the embryonal teratomas in animals, I believe that in both plants and animals they must have the same origin, *i. e.*, must arise from an identical chemical and physical stimulus. So far I have been able to explain the embryonal teratomas only on the assumption that in all animals and in all plants (except the simplest) certain widely distributed normally arranged cells or groups of cells, possibly all cells when very young and plastic carry the potentiality of the whole organism, which potentiality is not ordinarily developed on account of division of labor, but which comes into action when hindrances are removed, *i. e.*, when the physiological control is disturbed or destroyed. We know that life must have begun so in unicellular plants and animals and there is no good reason why it should not have continued so in multicellular ones. Only we have not been accustomed to think of it in this way, yet there are many facts respecting regeneration of lost parts in both plants and animals which coincide perfectly with this view. Coinciding with this view as to the origin of embryomas in various organs, *i. e.*, from groups of normal but very young undifferentiated or but slightly differentiated cells or groups of cells multiplying under a cancer stimulus, is the fact that I have been able to produce the teratomas in tobacco leaves only by inoculating very young leaves. When older leaves are inoculated they either do not respond or yield only the ordinary crown galls.

I may be permitted a few general remarks in conclusion, premising that this is the way the cancer problem looks to an experimental biologist.

With some praiseworthy exceptions, the cancer specialists of to-day, following the lead of the Germans, and their English imitators, are lost in a swamp of morphology, and it is time that an entirely new set of ideas should be promulgated to rescue them from their self-confessed hopelessness.

When a pathologist can say: "Concerning the ultimate nature of neoplastic overgrowth we shall never have more than a descriptive knowledge," he has reached the end of the road in his direction and the limit of pessimism! I do not care a rap whether I am called orthodox or heterodox, but I do care tremendously to keep an open mind and a hopeful spirit. One trouble with too many cancer specialists is that they are not *biologists*, whereas the cancer problem is peculiarly and preeminently a biological problem. These cancer morphologists have patiently cut and stained and studied hundreds of thousands of sections of tumors, fining and refining their defini-

[8] See *Journal of Agric. Research*, April 24, 1916, Plate XXIII.

tions and distinctions and *building up high walls of separation where nature has made none,* all because they do not understand the plasticity of living, growing things. I do not mean to condemn the study of sections, but only to suggest that there are also other ways of looking at this problem, which is one of growing things. There is too much reasoning in a circle on the part of many of these writers, too much argument basing one assumption on another assumption as if the latter were a well-established and solid fact, too little clear thinking of a biological sort, too little first-hand knowledge of living plants and animals, too much dogmatism, too much *orthodoxy,* and not enough experimentation. Hence the pessimism and the discouragement.

Cancer research was born in Germany and has been prosecuted there more diligently than anywhere else in the world, and they have done wonders in the study of its morphology, but etiologically the best the Germans have been able to do has been to cover the whole situation with a cloud of obscurity. With a few uninfluential exceptions they have denied the parasitic nature of the disease and discouraged search for an organism, and in this pessimistic attitude they have been ably seconded by their English followers. These strong men, chiefly morphologists, have dominated the situation for a generation, but they have not explained cancer and they can not explain it, and they must now give way. Indeed, from Cohnheim to Ribbert there is not one of their arguments in opposition to the parasitic nature of cancer which is not as full of holes as a skimmer!

Listen to Ribbert in his last great book:[9]

Denn wenn auch durch Mikroorganismen knotige, tumorähnliche Wucherungen hervorgerufen werden können, so handelte es sich doch stets nur um die Bildung eines entzündlichen Granulationsgewebes, das höchstens mit Tumoren der Bindegewebsgruppe eine gewisse Ähnlichkeit haben konnte (p. 378).

In other words, the most that parasites can do is to produce a granulomatous tumor superficially like a sarcoma.

Again he says:

Aber wenn das fremde Lebewesen die Zellen bewohnt, müssen diese notwendig geschädigt werden. Das folgt aus dem Begriff der Parasiten, der selbstverständlich der Zelle nur Nachteil bringen kann. Damit ist aber die den Tumor characterisierende Steigerung der Wachstumsfähigkeit der Zelle nicht vereinbar (p. 384).

In other words, when a parasite occupies a cell that cell must necessarily be injured. It follows out the very concept of a parasite that it can only bring injury to a cell, and the characteristic increase of cell growth in tumors is incompatible with this idea. Here as usual he just misses the point.

Ribbert ends his great book, of which "seine Entstehung" is its weakest part, although the illustrations are also to be criticized because they are all vague wash drawings when they should have been exact photomicrographs, as follows:

Das Karzinom entsteht auf Grund einer durch Epithelprodukte bewirkten die Differenzierung des Epithels vermindernden und sein Tiefenwachstum auslösunden subepithelialen Entzündung.

In other words, if I understand him, cancer is due to a subepithelial inflammation induced by substances arising in the epithelium, which substances cause it (or which inflammation causes it) to be less well differentiated and to grow downward. This, etiologically, is about as clear as mud!

Wilms, also, at the end of his book,[10] sarcastically inquires:

Welches Bakterium soll wohl eine Keimblattzelle, Mesoderm- oder Mesenchymzelle producieren können, die dann embryonale Gewebe und Organanlagen bildet?

[9] "Das Karzinom des Menschen sein Bau, sein Wachstum, seine Entstehung," Fr. Cohen, Bonn, 1911.

[10] "Die Mischgeschwülste," p. 275.

To which may be replied *Bacterium tumefaciens*, and probably others!

This is his additional and closing sentence designed to be a finality of invincible logic:

Wer diese genannten angeborenen Sarkomaformen als durch Bakterien erzeugt betrachtet, übernimmt damit die Verpflichtung, auch für die Bildung seiner eigenen normalen Gewebe und Organe eine bakterielle Infektion nachzuweisen.

To which may be answered: Very well, and why not? Since a bacterial organism does just that in the plant!

I believe these old ideas and assumptions must be sifted, turned and overturned, and many of them wholly rejected if we are to find the truth.

Cancer, according to my notion, is a problem for the experimental biologist and the bacteriologist. The morphologist has gone as far as he can go and the energy of cancer research from now on must, I believe, be turned into new channels, if we are to expect results commensurate with the needs of humanity.

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ESTABLISHMENT OF A SCHOOL OF HYGIENE AND PUBLIC HEALTH BY THE ROCKEFELLER FOUNDATION

IN recognition of the urgent need in this country of improved opportunities for training in preventive medicine and public-health work and after careful study of the situation the Rockefeller Foundation has decided to establish a school of hygiene and public health in Baltimore in connection with the Johns Hopkins University, where it is believed that the close association with the Johns Hopkins Medical School and Hospital and with the school of engineering of the university furnish especially favorable conditions for the location of such a school. Dr. William H. Welch, now professor of pathology, and Dr. William H. Howell, professor of physiology in the university, will undertake the organization of the new school in its inception. The trustees of Johns Hopkins University have appointed Dr. Welch as director of the school, and Dr. Howell as head of the physiological department.

Funds will be provided by the foundation for the purchase of a site and the erection of a suitable building, in proximity to the hospital and the medical laboratories, to serve as the institute of hygiene, which will be the central feature of the school. Here will be housed various laboratories and departments needed in such a school, such as those of sanitary chemistry, of physiology as applied to hygiene, of bacteriology and protozoology, of epidemiology and industrial hygiene, of vital statistics, a museum, library, etc. Additional facilities for instruction and research will be supplied by the medical and engineering schools, the hospital and other departments of the university. Funds will be provided by the foundation for the maintenance of the school in accordance with plans which have been submitted.

It is expected that the school will be opened in October, 1917, as it is estimated that a year will be required for the construction and equipment of the institute and the gathering together of the staff of teachers.

As it is recognized that the profession of the sanitarian and worker in preventive medicine, however closely connected, is not identical with that of the practitioner of medicine and requires a specialized training, the school of hygiene and public health, while working in cooperation with the medical school, will have an independent existence under the university, coordinate with the medical school.

The school is designed to furnish educational and scientific opportunities of a high order for the cultivation of the various sciences which find application in hygiene, sanitation and preventive medicine, and for the training of medical students, physicians, engineers, chemists, biologists and others properly prepared, who wish to be grounded in the principles of these subjects, and above all for

the training of those who desire to fit themselves for careers in public-health work in its various branches. The most urgent need at the present time is provision for the training of prospective health officials and for supplementary and advanced courses for those already engaged in public health service. Satisfactory completion of work in the school will be suitably recognized by the bestowal of certificates and degrees.

It is anticipated that mutually helpful relations will be established with municipal and state departments of health and the federal public health service, whereby opportunities will be afforded for field work and other practical experience in various departments of public health work. Especially advantageous will be the relations with the International Health Board of the Rockefeller Foundation, which is engaged in the study and control, not only of hookworm, but also of malaria, yellow-fever and other tropical diseases in various parts of the world.

The influence and usefulness of the school of hygiene and public health will be extended toward education of the public by exhibits, lectures and other means in a better appreciation and understanding of the importance and needs of public and personal hygiene, in cooperative efforts for the training of public health nurses, and in other directions.

The benefits to be expected from the establishment of such a school as that contemplated will not be measured solely by the number of students trained within its walls. A far-reaching influence should be exerted upon the advancement of the science and the improvement of the practise of public health, in establishing higher standards and better methods of professional education in this field, in stimulating the foundation of similar institutions in other parts of the country, in supplying teachers, and in cooperating with boards of health and other medical schools.

ENGINEERING EXPERIMENT STATIONS IN THE STATE COLLEGES

In the Senate of the United States on March 9, 1916, Mr. Newlands introduced the following bill, which was read twice and referred to the Committee on Agriculture and Forestry.

A Bill to establish experiment stations in engineering and in the other branches of the mechanic arts in connection with the colleges established in the several states and territories under the provisions of an Act approved July second, eighteen hundred and sixty-two, and of the Acts supplementary thereto.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with engineering and the other branches of the mechanic arts, and to promote the scientific investigation and experiment respecting the principles and applications of the mechanic arts, there shall be established under the direction of the land-grant college in each state or territory established, or which may hereafter be established, in accordance with the provisions of an Act approved July second, eighteen hundred and sixty-two, entitled "An Act donating public lands to the several states and territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the Acts supplementary to said Act, a department to be known and designated as an "engineering" or a "mechanic arts experiment station."

Sec. 2. That it shall be the object and duty of said experiment stations to conduct original researches, to verify experiments, and to compile data in engineering and in the other branches of the mechanic arts as applied to the interests of the people of the United States, and particularly of such as are engaged in the industries; also to conduct researches, investigations and experiments in connection with the production, transportation, extraction and manufacture of substances utilized in the application of engineering and of other branches of the mechanic arts to industrial pursuits; water supplies as to potability and economic distribution; sewage purification and its ultimate inoffensive disposal; economic disposal of urban and manufacturing wastes; flood protection; architecture; road building; engineering problems connected with transportation, manufacturing and public utilities, and such other researches or experiments bearing directly on the various industries and occupations of the people of the United States as may in each case be deemed advisable, having due regard to the varying conditions, resources and needs of the people of the respective states and territories.

SEC. 3. That bulletins giving results of investigations or reports of progress shall be published at said stations at least once in six months, copies of which shall be sent to persons, newspapers, institutions and libraries interested in engineering and in other branches of the mechanic arts as may request same in the states and territories in which the stations are respectively located, and to others as far as the means of the stations will permit.

Such bulletins or reports, and the annual reports of said stations, shall be transmitted in the mails of the United States free of charge for postage under such regulations as the Postmaster General may from time to time prescribe.

SEC. 4. That for the purpose of paying the necessary expenses of conducting investigations and experiments, printing and distributing the results as hereinbefore described the sum of $15,000 per annum is hereby appropriated to each state and territory, to be specially provided for by Congress in the appropriation from year to year, out of any money in the treasury not otherwise appropriated, to be paid in equal quarterly payments on the first day of January, April, July and October in each year to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, nineteen hundred and sixteen.

SEC. 5. That whenever it shall appear to the Secretary of the Treasury from the annual statements of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 6. That in order to secure as far as practicable uniformity of methods and economical expenditure of funds in work of said stations the supervision of the proposed experiment stations shall rest with the Secretary of the Interior.

It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the state or territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of the other stations provided for in this Act, to the Secretary of the Interior and to the Secretary of the Treasury of the United States.

SEC. 7. That nothing in this Act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the states or territories in which they are respectively located.

SEC. 8. That nothing in this Act shall be held or construed as binding the United States to continue any payment from the Treasury to any or all the states or institutions mentioned in this Act, but Congress may at any time amend, suspend, or repeal any or all the provisions of this Act.

This bill, appearing to be an important measure for the advancement of research, the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science has adopted the following resolutions:

WHEREAS the applications of science have made democracy possible by so decreasing the labor required from each that equal opportunity can be given to all;

WHEREAS in a democracy scientific research, which is for the general benefit and can not usually be sold to individuals, must be supported by the public;

WHEREAS a combination of national and state support and control is desirable in education and in research and its value has been fully proved by the Land Grant Colleges of Agriculture and the Mechanic Arts, established in the states and territories by the Congress in 1862;

WHEREAS there is in connection with each of these colleges an agricultural experiment station to which the national government appropriates annually $30,000 for agricultural research, the results of which have been of untold value to agriculture and to the nation;

WHEREAS experiment stations for the mechanic arts and engineering, including in their scope research in physics, chemistry and other sciences, would be of equal value to the nation and would repay manyfold their cost, and

WHEREAS at the present time attention is directed to the need of preparation for every emergency, and this can best be accomplished by the advancement of science and the ability of our people to meet new conditions as they arise;

Resolved that the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science earnestly recommends the passage of the senate bill introduced by Mr. Newlands to establish experiment stations in engineering and in the other branches of the mechanic arts in connection with the colleges established by the Congress in the several states and territories,

with an annual appropriation to each of $15,000 for conducting investigations and experiments and printing and distributing the results; and further

Resolved that the committee urges each of the ten thousand members of the American Association for the Advancement of Science to use all proper efforts to bring the importance of the measure before members of the Congress and to the attention of the public.

J. McKeen Cattell,

June 20, 1916

SCIENTIFIC NOTES AND NEWS

Dr. William J. Mayo, of Rochester, Minnesota, has been elected president of the American Medical Association, in succession to Surgeon General Rupert Blue, U. S. N.

Dr. A. B. Macallum, professor of physiology in the University of Toronto, has been elected president of the Royal Society of Canada.

Professor William J. Beal, formerly professor of botany at the Michigan Agricultural College, has received the degree of doctor of agriculture from Syracuse University.

Three degrees of doctor of laws were conferred at the recent commencement exercises of the University of Missouri at Columbia, as follows: Curtis F. Marbut, graduate and former professor of geology in the University of Missouri, now in charge of the national soil survey organized by the U. S. Department of Agriculture; Henry Jackson Waters, president of the Kansas State Agricultural College, a graduate and former dean of the agricultural faculty of the University of Missouri; and Roscoe Pound, dean of the Harvard University School of Law.

Professor Edwin G. Conklin, of Princeton University, will give the William Ellery Hale lectures at the autumn meeting of the National Academy of Sciences.

Sir Arthur Evans, F.R.S., will preside over the eighty-sixth annual meeting of the British Association for the Advancement of Science to be held at Newcastle-upon-Tyne on September 9. The following are the presidents of sections: A (mathematical and physical science), Dr. A. N. Whitehead; B (chemistry), Professor G. G. Henderson; C (geology), Professor W. S. Boulton; D (zoology), Professor E. W. MacBride; E (geography), Mr. D. G. Hogarth; F (economic science and statistics), Professor A. W. Kirkaldy; G (engineering), Mr. G. G. Stoney; H (anthropology), Dr. R. R. Marett; I (physiology), Professor A. R. Cushny; K (botany), Dr. A. B. Rendle; L (educational science), Rev. W. Temple; M (agriculture), Dr. E. J. Russell.

Sir David Prain, director of the Kew Botanical Gardens, has been elected president of the Linnean Society.

Dr. Emil von Behring, professor of hygiene at Marburg and director of the Institute of Experimental Therapy, has for reasons of health retired from active service.

Dr. L. H. Bailey has assembled the addresses delivered by him as vice-president of Section M (agriculture) of the American Association for the Advancement of Science, which were published in Science, and two others of similar character, and published them privately under the title "Ground Levels in Democracy." He offers to send the booklet free, as long as the supply lasts, to persons interested, upon application to his home address, Ithaca, N. Y.

Professor Herbert E. Gregory, of Yale University, who has been spending the winter in the Australian deserts, has returned to New Haven.

The International Health Commission of the Rockefeller Foundation sent to Brazil to make a general medical survey of the southern part of the country, has returned. The commission consisted of Professor Richard M. Peirce, of the University of Pennsylvania, chairman; Major Bailey K. Ashford, of the U. S. Medical Corps; Dr. John A. Ferrell, of the International Health Commission, and a secretary. They were absent for about four months and the work included a study of the general educational system in Brazil, the medical schools, hospitals and dispensaries, and public health organization.

THE Carnegie Institution expedition to Tobago, British West Indies, was exceptionally successful. The southwestern end of Tobago consists of elevated coral-bearing limestones and the coast from Milford Bay northward is flanked by a modern coral reef. Dr. Herbert Lyman Clark, of Harvard University, collected 73 species of echinoderms in this region, and of these Dr. Th. Mortensen, of Copenhagen University, reared 10 throughout their larval stages; among them a crinoid Tropiometra which was abundant over the shallow reef-flats. Dr. A. G. Mayer studied the Siphonophores, the pelagic life being abundant, due to the fact that the water of the great equatorial drift of the Atlantic strikes immediately upon the coast of Tobago. The coastal waters of Tobago are those of the clear blue tropical ocean, for the island lies to the northward of the muddy shores of Trinidad.

N. S. AMSTUTZ, of Valparaiso, Indiana, recently gave an illustrated lecture on the "Marvels of Illustration" during an afternoon meeting at the Bureau of Standards, Washington, D. C., and in the evening before the Association of Federal Photographers in the new National Museum.

TWO Harvard graduates and a member of the junior class in Harvard College will leave this month on an expedition to South America for the Harvard Museum of Comparative Zoology. The party, consisting of Dr. L. S. Moss, of Baltimore, a graduate of the medical school; Dr. C. Tello, a Harvard graduate who is now living in Lima, Peru, and G. K. Noble, '17, of Yonkers, N. Y., will sail from New York for Paita, Peru. From this point they will cross the Andes and into the Amazon Valley. The purpose of the expedition is to collect zoological specimens and to study the native tribe of Guarani Indians.

SIX physicians and six nurses, comprising the sixth medical relief expedition to be sent from the United States to the Central Powers under the auspices of the American Physician's Expeditions Committee, have left New York on board the Holland-American line steamship *Ryndam* for Rotterdam, whence they will proceed to Austria. The party is headed by Dr. Joseph Irilus Eastman, of Indianapolis, professor of surgery in the University of Indiana.

THE Royal Society has awarded to Miss Dorothy Dufton, of Girton College, Cambridge, the first year's income of their Lawrence Fund, for an investigation of pneumonia produced by poisonous gases. The income of the Lawrence Fund, about £160 a year, is devoted to research in the relief of human suffering. Miss Dufton is the daughter of Dr. S. F. Dufton, inspector of schools in Leeds, and is doing research work in Cambridge University Physiological Laboratory.

UNIVERSITY AND EDUCATIONAL NEWS

THE magnificent new buildings of the Massachusetts Institute of Technology, on the Cambridge side of the Charles River, were dedicated last week with imposing ceremonies. At the formal dedicatory exercises on June 14, addresses were made by President Richard C. Maclaurin, by President A. Lawrence Lowell, of Harvard University, now allied with the institute, by Governor Samuel W. McCall, and by Senator Henry Cabot Lodge.

THE tenth annual report of the Carnegie Foundation for the Advancement of Teaching, published on June 19, shows that the income from general endowment was $697,892, and the expenditures $712,852. The income from the endowment of the Division of Educational Enquiry was $50,300, and the expenditures $54,633.

AT the commencement exercises of Wesleyan University the Van Vleck Astronomical Observatory, the gift of the late Joseph Van Vleck, of Montclair, N. J., was dedicated.

To represent the faculty of Cornell University as delegates at the meeting of the board of trustees, the following have been elected: Dexter S. Kimball, professor of machine design and industrial engineering; Walter F. Willcox, professor of economics and statistics, and John Henry Comstock, emeritus professor of entomology and general invertebrate zoology.

MR. ERNEST MARTIN HOPKINS, until 1910 secretary of Dartmouth College and since en-

gaged in business in Boston, has been elected president of the college, to succeed President Ernest Fox Nichols, who has resigned to accept a chair of physics at Yale University.

At the University of Nebraska, Dr. David D. Whitney, now at Wesleyan University, Middletown, Conn., has been appointed professor of zoology, in charge of courses in the fields of genetics, evolution and experimental zoology. Homer B. Latimer, now professor of zoology in Nebraska Wesleyan University, has been appointed associate professor of zoology, in charge of work in vertebrate anatomy, embryology and histology.

George Frederic Ordeman, Ph.D., has been elected associate professor of chemistry, and Robert William Dickey, Ph.D., associate professor of physics in Washington and Lee University.

At Sibley College, Cornell University, the following instructors have been promoted to the grade of assistant professors: Clarence Andrew Pierce, in power engineering; Myron A. Lee, in machine design, and John George Pertsch, Jr., in electrical engineering. Joseph Franklin Putnam has been appointed assistant professor of electrical engineering. He has been professor of physics in St. John's College, Shanghai. Frederick George Switzer has been appointed instructor in the mechanics of engineering.

Vera Dantschakoff, M.D., of the Rockefeller Institute for Medical Research, has been appointed instructor in anatomy, and Rosalie F. Morton, M.D., as attending surgeon at Vanderbilt Clinic of the College of Physicians and Surgeons of Columbia University.

Recent additions to the faculty of the University of Arkansas are J. Sam Guy, Ph.D. (Johns Hopkins), head of the department of chemistry, succeeding the late Dr. C. G. Carroll; F. G. Baender, M.S. (Cornell University), formerly assistant professor in the University of Iowa, head of the department of mechanical engineering; P. B. Barker, late of the agricultural faculty of the University of Missouri, head of the department of agronomy. Arthur M. Harding, Ph.D. (Chicago), returns to the university, after a year's leave of absence, as professor of mathematics and university examiner.

DISCUSSION AND CORRESPONDENCE

CORAL REEFS

To the Editor of Science: In his article on "Coral Reefs" in the April *Scientific Monthly*, Professor Davis gives an abridged and distorted version of Alexander Agassiz's theory, thus setting up a dummy to be conveniently knocked down. A careful consideration of *all* the forces suggested by Agassiz as contributing to the formation of atolls and barrier reefs should convince Professor Davis that the hypothesis calls for neither cliffs, deltas nor talus on the islands enclosed by barrier reefs. For the ring of living corals breaks the force of the waves; and the great quantities of water piled over the reef by the trade winds forms a gigantic modified pothole which scours out the material eroded from the island. Professor Davis has stated that any theory would account for the formation of atolls and barrier reefs themselves. He appears to forget that it was because many investigators in the field were unable to reconcile the facts observed with the theory of subsidence that led them to suggest other explanations. Any one at all familiar with the methods of work of both the elder and younger Agassiz would never think of quietly assuming that either was ignorant of the literature of his subject.

G. R. Agassiz

ANOTHER POISONOUS CLAVICEPS

The results of the experiments by Brown and Ranck, showing the poisonous action of *Claviceps paspali* Stevens and Hall on animals, published in Technical Bulletin 6, Mississippi Agricultural Experiment Station, has just been received by me and read with unusual interest, as I have followed the history of this interesting fungus since 1902.

I first noticed the disease produced by *Claviceps* very abundant and conspicuous on *Paspalum læve* in Maryland in the summer of 1902, and in the autumn of the same year a sample of it was received from a Maryland

farmer who had taken it from a field where cattle had died with symptoms of poisoning. The similarity of these sclerotia to the common ergot gave further indication of its probable poisonous character and a quantity of the diseased grains was collected for testing, but no animals were available at the time and learning from Professor P. H. Rolfs that he was working on the life history of the fungus (as recorded by Stevens and Hall when they published descriptions of the two *Paspalum* ergots in the *Botanical Gazette* in 1910) the matter was dropped. There was, however, a short note on these observations published in my report on plant diseases in Maryland in 1902, in the Maryland Horticultural Society Report for 1902, as follows: "A fungus disease causing the seeds of a wild grass (*Paspalum læve*) to expand and break open like popcorn has been abundant and has been suspected of being poisonous to cattle."

Since then a few cases of stock disease, sometimes confused with the well-known but yet little understood "horse disease," have occurred in Maryland, where the *Paspalum* ergot was abundant enough to be suspected and, judging from the experimental results so well worked out in Mississippi, was without much doubt the cause of the trouble.

The *Claviceps* sclerotia which replace the *Paspalum* grains are frequent in Maryland nearly every year, though in some years almost absent and sometimes, as in 1915, unusually abundant.

J. B. S. NORTON
AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MD.

NAMES OF CELESTIAL ELEMENTS

I WISH to learn the name of the giver and first place of publication of the following: Neptunium of Mendeléef, cited by Biclok and Martin; Coronium (the same as Mendeléef's "x"), said to be by Huggins; Helium, Aurorium and Nebulum (or Nebulium), the last two cited by Crookes, presidential address Brit. Ass. 1898. Any one who can give me any one of the citations will confer a favor upon the subscriber.

B. K. EMERSON
AMHERST, MASS

QUOTATIONS

ENGINEERING EXPERIMENT STATIONS IN THE LAND GRANT COLLEGES

ON July 2, 1862, President Lincoln approved the act establishing the Land Grant Colleges of Agriculture and the Mechanic Arts, and on March 3, 1863, he approved the act incorporating the National Academy of Sciences. When the nation was stricken down with civil war it sought relief in science, on the one hand, establishing institutions for the scientific education of all the people in the arts of peace, on the other hand, recognizing exceptional merit in science and making the most distinguished men of the country the advisers of the government.

Now when the world is again infected by war more terrible than can be imagined in this one great nation which has escaped, we are naturally driven to think of "preparedness," and it will be well if this movement can be directed to making the nation strong through education and scientific research. At least three bills are before the Congress which are more important for the welfare of the country and its defense from foreign aggression, should that ever become necessary, than any enlargement of the army and navy. These bills would establish a national university, extend secondary education in industry and agriculture, and establish research stations for engineering at the college of agriculture and mechanic arts.

A national university at Washington, holding the same position toward the state and privately endowed universities as these hold or should hold to the colleges and schools of each state, would correspond with the establishment of the National Academy of Sciences during the civil war, but could be made far more effective in its influence on research and on the efficient conduct of the departments of the government.

The Smith-Hughes bill provides for the promotion of the vocational education of boys and girls of high-school age through cooperation of the nation and the states. There is appropriated for the first year $1,700,000 with an increment each year for eight years on condition that each cooperating state shall appro-

priate an equal sum. In the first year the sum of $200,000 is for administration and investigation, $500,000 for training teachers for vocational work, and $1,000,000 for payment of teachers, equally divided between agriculture, on the one side, and trade, home economics and industry, on the other.

Of special interest to scientific men is the Newlands bill establishing research stations in engineering, corresponding to the existing agricultural stations in the colleges of agriculture and the mechanic arts. These land grant colleges and their agricultural research stations have been of incalculable value to education, to agriculture, to the states and to the nation. They have been largely responsible for the establishment and development of the state universities. The land grant colleges and the institutions of which they are a part received in 1914 from the United States $2,500,000; from the states and from other sources over $30,000,000. They have 9,000 instructors and 105,000 students.

By the Hatch act of 1887 and the Adams act of 1906 the sum of $30,000 a year is appropriated for research in agriculture in the experiment stations. The colleges have more students of mechanic arts than of agriculture, but there is no similar provision for research in the mechanic arts and engineering, and the sciences, such as physics and chemistry, on which they are based. The agricultural interests have always had great influence on legislation and in this case they have led the way. It is to be hoped that research in the engineering sciences will now be equally encouraged by the passage of the Newlands bill, which appropriate $15,000 to each state and territory for conducting investigations in engineering and publishing the results.

Some scientific men may believe that more could be accomplished by the establishment of one great research laboratory or by granting the money only to institutions already distinguished for their contributions to science. There is, however, much to be said for initiating investigation in fifty widely scattered centers where work is already being done in agricultural science. It brings the value of research to the attention of the students of the college and the people of the state, and each station has the possibility of great development. In any case the passage of the bill as it stands is the most feasible method at present to extend research and will forward rather than interfere with other methods.—*The Scientific Monthly.*

SCIENTIFIC BOOKS

The Mathematical Theory of Probabilities. By Arne Fisher, F.S.S. Translated and edited from the author's original Danish notes with the assistance of William Bonynge, B.A., with an introductory note by F. W. Frankland, F.I.A., F.A.S., F.S.S. New York, The Macmillan Company. Vol. I. Pp. ix + 171.

Although a considerable number of standard text-books on probability have appeared in recent years in foreign languages, there is a lack of such books in the English language. Both on this account and because of the selection of subject-matter, the present book should be particularly useful. Research work in the theory of probability has received during the past twenty years a new impetus, through the labors of certain mathematical statisticians. In this connection, we may perhaps mention particularly the work of Pearson in England, Lexis in Germany, Westergaard in Denmark. Each group of investigators seems to have moved along its particular line. In the present work an attempt is made to treat these researches from a common point of view based on the mathematical principles grounded in the work of Laplace, "Theorie analytique des Probabilites."

The introductory chapter consists of a brief discussion of the general principles and philosophical aspects of a theory of probability. Here, in the determination of what events are to be regarded as "equally likely," both the principle of "insufficient reason" and the principle of "cogent reason" are illustrated, and the inference is drawn that a compromise of the two principles gives us a valuable meaning of "equally likely." Then follow some interesting historical and biographical notes.

The definition of mathematical probability from which are developed the elementary theorems of probability is quoted from Czuber, and is about the usual definition of *a priori* probability. The author is rather emphatic in his criticism of the idea of replacing the *a priori* probabilities of Laplace by the empirical ratios of Mill, Venn and Chrystal. He believes the distrust of *a priori* probabilities is due to a misapprehension of the true nature of Bernoulli's theorem, which is the cornerstone of the theory of statistics. The chapter on probability *a posteriori* deals with the criticisms of Bayes's rule in a rather constructive manner, by indicating the limitations under which Bayes's rule will give correct results in practise. The author makes the connection between *a priori* probabilities and statistical series by the use of the well-known theorem of Tchebycheff. In this connection he offers a proof that the limit of a relative frequency α/s when s becomes infinite is the postulated *a priori* probability p. It seems to the reviewer that the notion of limit here employed is not quite the rigorous notion; for, the statement that the probability that $|\alpha/s - p| < \delta$ approached 1 as a limit, is not the same as the usual statement that $|\alpha/s - p|$ becomes and *remains* less than δ. The author does not seem to discriminate in this connection between a point of condensation and a limit point.

One of the most interesting and important parts of this book is its neat and striking applications of Bernoulli, Poisson and Lexis series to the characterization of actual data. Furthermore, the application of the Lexian ratio and of the Charlier coefficient of disturbancy is clearly shown. Taken as a whole, this book will be found of much value to students of the mathematical methods in statistics.

H. L. RIETZ

Gould's Practitioner's Medical Dictionary. Third edition, revised and edited by R. J. E. SCOTT, M.A., B.C.L., M.D., of New York. Pp. xx + 962. Flexible cloth, round corners, marbled edges. P. Blakiston's Son & Co., Philadelphia. Price $2.75.

The history of medical dictionaries begins with the fifteenth century. The first works of the kind are the "Synonyma" (Venice, 1473) of Simone de Cordo or Simon of Genoa and the contemporary Pandects of Mathæus Silvaticus. Both these works are alphabetical lists of medicinal simples, but a goodly number of real medical dictionaries were published during the Renaissance period, in particular those of Lorenz Fries or Phryesen (1519), Henri Estienne or Stephanus (1564) and Jean de Gorris (1564).

In the seventeenth century appeared the famous "Lexica" of Bartholommeo Castelli (1607) and Steven Blancard (1679) which passed through many editions. After these the number of medical dictionaries is legion. Among the best known of more recent times are those of Robert James (London, 1743) and P. H. Nysten (Paris, 1810), which, in 1855, was entirely rewritten by Emile Littré and Charles Robin and is still a standard source of reference. In England, the dictionary of the New Sydenham Society (1878–99), in America that of Frank P. Foster (1888–93), and in France, Galtier-Boissière's "Larousse Médical illustré" (1912), are monuments of scholarship. Gould's large illustrated medical dictionary (1894), frequently revised and reedited, has been of great practical use to the medical profession. Of late years the tendency has been towards handy volumes of reasonable thickness, printed on thin paper, with flexible covers, and of these the new edition of Gould's Practitioner's Dictionary is an excellent example.

This new edition is unsurpassed as to comprehensiveness, clearness and size. It contains over 70,000 words. To reduce the size of the book and to make it a handy volume a small type had to be selected, but the type is very clear and legible and is even a little larger than that used in Webster's Unabridged Dictionary. Each word is accompanied by its pronunciation and followed by its etymology. The definitions are clear and concise.

The book contains all the numerous and latest eponyms in their proper alphabetical order, such as Abderhalden's test, Alzheimer's disease, Lane's kink, Meltzer's method,

Schlatter's disease. An important feature is the large number of new words with which the medical vocabulary has been enriched during the last few years. The book contains such new words as anoci-association, biometer, colliculectomy, gassed, keritherapy, leukotoxic, serobacterins, sympathoblasts, etc.

This handy, practical book, in octavo size. 1¼ inches thick, containing nearly 71,000 words, is unique among modern dictionaries and can not fail to receive a hearty welcome by the medical practitioner and the student of medicine.

A. Alleman

Army Medical Museum

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

(Volume 2, Number 5)

The fifth number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *The High Frequency Spectrum of Tungsten:* Albert W. Hull and Marion Rice, Research Laboratory, General Electric Company.

The authors show two photographs of the spectrum of X-rays taken in the usual manner in a rock-salt crystal. They also give figures which show the ionization current as a function of the angle of incidence. A comparison with previous results obtained by others is sketched.

2. *On the Foundations of Plane Analysis Situs:* Robert L. Moore, Department of Mathematics, University of Pennsylvania.

As point, limit-point and regions (of certain types) are fundamental in analysis situs, the author has set up two systems of postulates for plane analysis situs based upon these notions; each set is sufficient for considerable body of theorems.

3. *A General Theory of Surfaces:* Edwin B. Wilson and C. L. E. Moore, Department of Mathematics, Massachusetts Institute of Technology.

Continuing the work of Kommerell, Levi and Segre, a theory of two-dimensional surfaces in n-dimensional space is developed by the method of analysis outlined by Ricci in his absolute differential calculus.

4. *Dynamical Stability of Aeroplanes:* Jerome C. Hunsaker, U. S. Navy and Massachusetts Institute of Technology.

A comparative detailed study of two aeroplanes, one a standard military tractor, the other designed for inherent stability, is made for the purpose of reaching general conclusions of a practical nature with respect to aeroplane design. It appears that inherent stability (except at low speed) can be obtained by careful design without departing seriously from the standard type now in use.

5. *Cliffed Islands in the Coral Seas:* W. M. Davis, Department of Geology and Geography, Harvard University.

The author extends his former work on the Origin of Coral Reefs to include the explanation of the cliffs of exceptional reef-encircled islands of which no adequate explanation has previously been given.

6. *On Some Relations between the Proper Motions, Radial Velocities and Magnitudes of Stars of Classes B and A:* C. D. Perrine, Observatorio Nacional Argentino, Cordoba.

The velocity distribution of classes *B*–*B*5 and *A* differ from the distributions found for the *F*, *G*, *K* and *M* classes by Kapteyn and Adams.

7. *Asymmetry in the Proper Motions and Radial Velocities of Stars of Class B and Their Possible Relation to a Motion of Rotation:* C. D. Perrine, Observatorio Nacional Argentino, Cordoba.

Stars of class *B* show differences in the proper motions in the two regions of the Milky Way at right angles to the direction of solar motion; the differences appear to be best explained by a general motion of rotation of the system of stars in a retrograde direction about an axis perpendicular to the Milky Way.

8. *Theory of an Aeroplane Encountering Gusts:* Edwin Bidwell Wilson, Department of Mathematics, Massachusetts Institute of Technology.

The longitudinal motion of an aeroplane encountering head-on, vertical, or rotary gusts is discussed by the method of small oscillations.

An inherently stable machine striking a head gust of J feet per second soars to altitude of about $4\frac{1}{2}$ J feet above its initial level and, after executing oscillations, remains about $3\frac{1}{2}$ J feet above the original level.

9. *Terms of Relationship and Social Organization:* TRUMAN MICHELSON, Bureau of American Ethnology, Washington, D. C.

From the point of view of Algonquian tribes terms of relationship are linguistic and disseminative phenomena, though in other cases they may be primarily psychological and sociological.

Report of the Annual Meeting: Prepared by the Home Secretary.

This report has appeared in full in SCIENCE.

EDWIN BIDWELL WILSON
MASS. INSTITUTE OF TECHNOLOGY

SPECIAL ARTICLES

THE SCALES OF THE GONORHYNCHID FISHES

THE Gonorhynchidæ constitute a small family of very peculiar marine fishes of elongate form, found in the seas about Japan, Australia and South Africa. In the Eocene deposits of Wyoming is a fish which Cope named *Notogoneus osculus,* considered to belong to the Gonorhynchidæ. Whitfield in 1890[1] gave an account of a specimen of this species, and expressed the opinion that it belonged in the vicinity of the suckers, or Catostomidæ. It seemed remarkable that a fish from a fresh or brackish water deposit in Wyoming should be referred to a rare marine family of a remote region of the earth; and the scales of *Notogoneus,* admirably figured by Whitfield, did not at all resemble those of the Isospondylous fishes in general, neither had they any resemblance to those of the Catostomidæ. Wishing to apply the more exact methods of comparison of later times, I asked Dr. D. S. Jordan for scales of *Gonorhynchus,* and he has very kindly sent material from *G. abbreviatus* Schlegel, obtained by Alan Owston in the Yokohama (Misaki) market, Japan. These scales wholly confirm the reference of *Notogoneus* to the Gonorhynchidæ, and afford a remarkable illustration of the constancy of scale-structure through millions of years and migrations over the earth. The long parallel-sided scales of *G. abbreviatus* are narrower than those of *N. osculus,* and the truncate base is crenulate, but the peculiar structure is entirely the same. The apical margin has a single row of 18 or fewer (never so many as in *N. osculus*) teeth, which are long and stout, and connected by a thin lamina. Just below these is a broad sculptureless band, the same in living and fossil forms. The lateral circuli are strictly longitudinal and not very dense. Spreading fan-like from the subapical nucleus are the radii (about 12), closely set, with longitudinal bands of curved lines, derived from the system of circuli, between them.

Jordan and Snyder[2] say of *G. abbreviatus:*

> Mr. E. C. Starks has examined the shoulder girdle of this species; it has the mesocoracoid arch, as usual with Isospondylous fishes. Its place is apparently with the earliest and most generalized of these forms.

The scales, however, are more like those of Acanthopterygians. Coming to details of structure, we find a striking resemblance to the scales of *Aphredoderus,* of which genus Jordan says: "Probably the most primitive of all living Percoid fishes, showing affinities with the Salmopercæ" (to which group Regan has more recently referred it). *Aphredoderus* has the same type of marginal teeth, though there is no hyaline band beneath them and the radii are few. Marginal teeth of the same type are found in another group, little related to *Aphredoderus* or *Gonorhynchus;* namely, the Characiform genus *Distichodus* of the fresh waters of tropical Africa. The rest of the *Distichodus* scale shows no close resemblance to that of *Gonorhynchus.*

We have, then, evidence of the extreme constancy of scale characters, even minute details, in the Gonorhynchidæ. On the other hand, the most striking feature of the Gonorhynchid pattern appears, not in the presumed allies of that family, but in other families supposed to be very far removed from it. Is this wholly a matter of independent evolution,

[1] *Bull. Amer. Mus. Nat. His.,* III., p. 117.

[2] Smithsonian Misc. Coll., 45 (1904), p. 236.

or did the Gonorhynchids early develop a type of scale-structure which has survived here and there in remote descendants? The actual origin of this type of scale may date back of the Gonorhynchids, but it is nevertheless a specialized structure, which in the absence of evidence to the contrary would be thought to be of relatively recent origin.

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ANTHROPOLOGY AT THE WASHINGTON MEETING

IV

The European and the American Child: Paul R. Radosavljevich.

On the basis of a summary study of 50,000 Europeans and 50,000 American school children, represented by various European and American authors, it is shown that the most important factors are: (1) age, (2) sex, (3) race; and the least important are (4) school brightness, and (5) environment. The general average values of these measurements for both European and American pupils are very much alike, the difference being most evident in their variations. American pupils vary more than their European brothers and sisters at all the school ages studied (5–20 years). Hebrew children show the greatest variation; then Anglo-Saxon; then Latin, and least variation is shown by Slav pupils. If we take in account, however, not the variation based on general arithmetical averages, but on individual cases of such racial groups, then we see that the difference in the variation (or distribution) of one group, say the Slavic group, is greater than the difference of variation between two groups.

This variation, however, is not uniform for all measurements: that for body heights and weights is the greatest, while that for the two common head diameters is the least. This might be due, of course, to the inaccuracy of measurements, or to the statistical treatment, or to the personal equation of the investigators, or to the collective method of taking the measurements, etc., or to all of these factors. It is, therefore, for the present at least, very hard to accept many of the conclusions derived from these data, for it is an established fact that a mere statistical interpretation of these results is not *eo ipso* a biological-anthropological possibility, nor, furthermore, that such a possibility carries with it a pedagogical necessity.

Pedagogical Anthropology in the United States: Paul R. Radosavljevich.

Physical anthropology of pupils in the United States is beginning to develop along scientific lines, both in regard to the method of collecting data and in describing and explaining these inductive facts. The purpose of school anthropometric investigation in the United States has been based on all kinds of criteria, but not on primarily scientific-pedagogical criteria. These criteria might be grouped into (*a*) statistical-correlative (Boas, Bowditch, Porter, Peckham, Byer, Macdonald, West, Baldwin, *et al.*; (*b*) hygienic-comparative (Sargent, Hitchcock, Seeley, Seaver, Crampton, Fuld, Smedley, Hastings, *et al.*); (*c*) pathological-comparative (Wyley, Bar, Goddard, *et al.*).

Scientific anthropological criterion in the study of physical traits of children and youth is suggested in the works of Dr. Aleš Hrdlička and B. A. Gould, who combine the spirit of three great European schools in pedagogical anthropology (Meumann-Martin school in Germany, Godin school in France, and Sergi school in Italy). This criterion might be called biological-pedagogical, a criterion which has been more or less propagated among educators by G. Stanley Hall's "Adolescence," and the recently translated Montessori's "Pedagogical Anthropology," the only two general books on pedagogical anthropology published in the United States.

The future of scientific pedagogical anthropology in the United States will depend largely on the establishment of (*a*) an anthropological-pedagogical museum, (*b*) an anthropological-pedagogical laboratory, and (*c*) special academic chairs for pedagogical anthropology, the scientific discipline of which will be binding on all those who are studying education, psychology, sociology and criminology.

The Comparative Convolutional Complexity of Male and Female Brains: E. E. Southard.

The material for the study consists of brain photographs (six views of each brain) in the collection of the Massachusetts State Board of Insanity, derived from over 500 brains in the possession of various state and private institutions of Massachusetts, including so-called "normal" brains and brains from a variety of psychopathic subjects. The method of the study is numerical, based upon counts of fissures and fissurets. The results, so far as interpretable, show no great sex difference in degree of fissuration.

LIBRARY OF EVANGELICAL COLLEGE ALLAHABAD

Oracles of the Saints: PHILLIPS BARRY.

Divination, prohibited by decrees of early ecclesiastical councils, was not suppressed, but remained an important by-product of popular religion. Some effort was made by a lax clergy to establish a Christian technique in divination.

Divination by opening the Scriptures at random and taking as an oracle the first verse to meet the eye, originated with St. Augustine, persisted in spite of imperial and canon law, and is not yet extinct.

The "Oracles of the Saints"—a manual of divination for use of Christians, going back to the sixth century, may be shown by documentary evidence to have been compiled from catalogues of oracular texts used in local pagan temples—an evidence of the historic continuity between pagan and Christian divination.

Use of letters of the alphabet in divination, widely current in the Middle Ages, is of pre-Christian origin, and may be traced to the usage of Egypt-Greek magic and mystical cults.

Ballads Surviving in the United States: C. ALPHONSO SMITH.

Ballad singing is not a lost art, since 77 of the original 305 ballads are still sung in the United States and about 85 in Great Britain. In the recovery of the ballad in the United States, the South leads, Virginia reporting 36. Communal composition may be best illustrated by the camp-meeting songs of the southern negroes. "The Hangman's Tree" (No. 95) is popular among the negroes of Virginia as an out-of-doors drama. A comparison of ballad tunes shows greater variety than of ballad texts. American ballad tunes and American ballad texts may be older than their surviving parallels in Great Britain. They may go back to textual and melodic variants, which not only antedate the surviving British variants but which in some cases left no lineal British issue. A comparison, for example, of seven musical arrangements of "Barbara Allen," one from Scotland, one from England, and five recently transcribed from the lips of singers in Virginia, no one of whom understood music and four of whom were from the same county, proves that the differences are so great that neither the British nor the Scotch melody can be claimed as the original. A new field of comparative song is thus opened. (This paper appeared in full in *The Musical Quarterly*, edited by O. G. Sonneck, New York and London, January, 1916.)

Pan-American Topic: ABRAHAM ALVAREZ.

After a brief consideration of the importance of the study of the archeology of the American continent, the author proposes as a means of conserving the pre-Columbian monuments the following plan:

Article I. The American governments agree to establish a museum of American anthropology and archeology, which shall be called "Pan-American Museum."

Art. II. In this museum there shall be collected: (*a*) American antiquities, (*b*) mummies, (*c*) stuffed specimens of animals existing in the different countries from the time prior to the conquest to the present, (*d*) specimens of native plants, (*e*) native minerals, (*f*) collections of books relating to the ancient plans, photographs, chromolithographs and detailed descriptions of all the monuments and ruins of the pre-Columbian epoch, (*h*) maps of the respective countries showing the location of each race or tribe and the position of the ruins, (*i*) phonographs with records of the speech and songs of the Indian languages for the purpose of preserving said languages, (*j*) studies of all the native races, (*k*) studies of the different native languages.

Art. III. The ancient ruins shall be preserved and cared for by each government. They shall not be sold or given away or disposed of in any other manner. They shall be the property of the nation.

Art. IV. Each museum shall send to the other Pan-American museums reports of the anthropological and archeological work done during the year within its jurisdiction.

Art. V. All the objects to which Article II., section (*a*), refers shall be property of the state and should be placed in the museum, whatever may have been the place they were found.

The Desirability of Uniform Laws throughout the Pan-American Countries for the Encouragement and Protection of the Study of Archeology and Anthropology and the Collection of Material Relating to these Sciences: MAX UHLE.

The American nations have had only four centuries of existence on this continent. They lack, therefore, the long history which usually gives to other peoples strength and power of resistance in times of stress such as those through which all the nations of America have had to pass. The lack of a long national history must be made good by the study of the peoples, who occupied the territory before the time of Columbus. From this study lessons may be drawn applicable to national de-

velopment of the present time. The study of the pre-Columbian period in the Western Hemisphere must be based on the sciences of archeology and anthropology. The American governments have not yet recognized the importance of these two sciences as a means for deepening their knowledge of American history, and thus is to be explained the absolute neglect of the monuments and other archeological materials constituting the necessary basis for the study of the history of the pre-Columbian epoch. On account of this complete neglect the documents which existed on the surface of the earth and beneath the soil—documents which must serve as the source for the study of early American history—have unfortunately already been largely destroyed or removed from the American continent. It is, therefore, urgent that better protection should now be given the ruins that remain.

During the century of the conquest the peoples constituting the existing nations occupied the whole continent. There was thus formed a kind of historic unity, which implies the duty of studying the pre-Columbian period, as well as that of the later period. The cooperation of all the countries in this common task is all the more necessary, because, notwithstanding numerous points of difference, the continent appears to have presented a historic unity from the earliest times up until the development of the great native civilizations. The solution of the common historic problems is impossible unless all the countries advance along this line with equal step. It is, therefore, desirable that an agreement should be entered into by the different countries for the purpose of protecting the vestiges of antiquity within their respective territories in their own interest and in the common interest. The best way to accomplish this end is by means of appropriate uniform laws in all the countries.

The Study of the Convenience of Uniform Laws in all the American Countries, to Protect and Stimulate the Collection of Anthropological and Archeological Material and Data, and to Encourage the Study of the Same: Samuel Lainez.

In this report the author considers carefully the importance of the study of American anthropology and archeology; he examines the great problems of these sciences and their solution; indicates the work of investigation effected up to the present time and what is yet to be done in this vast field, and as a result of his study formulates 13 propositions with a view to stimulating and protecting, by means of uniform laws in all the American nations, the investigations whose object is the collection and study of anthropological and archeological material and data.

Service of the Academy of Natural Sciences of Philadelphia to American Anthropology: S. G. Dixon.

Anthropology excited the interest of the earliest naturalists in America. The first contributions to American anthropology show that among the earliest members of this institution were those who took an active part in American anthropology. True to the traditions of the older natural science institutions, the Philadelphia Academy shows by its publications that man was considered as an animal to be studied structurally. One of the first contributions to the subject was the great collections of human crania presented by Dr. Samuel G. Morton, which has been supplemented by Meigs and others. The collections of the academy have furnished material for important papers by Morton and the late Dr. Harrison Allen, besides many other students of anthropology.

Among the contributors to the literature of the subject are Brinton, Gabb, Halderman, Holmes, Hrdlička, Leidy, Meigs, Moore, Morton and Putnam. One of the lines of work of a substantial character done by the academy consisted in furthering the Arctic expeditions of Kane, Hayes and Peary, the last mentioned adding to our knowledge of the Greenland Eskimo. The Philadelphia Academy maintained a chair of anthropology for many years under Dr. Daniel G. Brinton. The Philadelphia Museum is rich in ethnographic and archeological specimens. Collections gathered by famous expeditions, beginning in 1805 with Lewis and Clark, were followed by Keating, Poinset, Meittal, Townsend, Rusemberger, Sharp, Gabb and Peary; but the most comprehensive of all have resulted from many expeditions of Clarence B. Moore, whose archeological collections from the southern states have no parallel.

The Archives of the Indies: History of and Suggestions for their Exploitation: Roscoe R. Hill.

The Archives of the Indies, founded at the close of the eighteenth century, is one of the richest collections of materials for colonial history in existence. Successive and proposed additions from Madrid and Simancas will make the collection cover completely the colonial history of the former oversea dominions of Spain.

The earliest use of the Archives was made by Muñoz for his "Historia del Neuvo Mundo," and by Navarrete for his "Colección de los Viajes y Descubrimientos." A more pretentious exploitation, aided by a subsidy from the Spanish government, resulted in the two series of the "Colección de Documentos Inéditos." This work was carelessly done, but serves to indicate the extent and richness of the Archives.

Extensive investigations have been made in settling boundary disputes of the Latin-American republics, and many documents have been published in this connection. Several governments, notably Argentina, Chile, Ecuador, Dominican Republic, Mexico and Cuba, at various times have commissioned individuals to study and make collections of documents for the history of their respective countries.

The exploitation by the United States has been carried on by private individuals or by institutions, like the Carnegie Institution or the universities of Texas and California. This has confined itself to describing and copying documents.

A suggested plan for further exploitation is based on international cooperation. Each of the American republics should have a director in Sevilla, and these should form a board or faculty for exploitation. Scholarships or fellowships should be maintained by the American governments and universities. The directors should supervise the studies of the scholars, and direct the investigation, cataloguing, copying, editing and publishing the documents relating to their respective countries.

The Origin and Various Types of Mounds in Eastern United States: DAVID I. BUSHNELL, JR.

The Indian mounds of the United States east of the Mississippi (this does not include effigies and inclosures) may be divided into three classes, namely: burial, ceremonial and domiciliary. Burial mounds are the most numerous; they form large groups in the area north of the Ohio, and near by are often traces of a former village; they are usually rather small, circular in outline, and, on examination, reveal burials of various types. But such mounds, isolated or in groups, are widely scattered over the valley of the Mississippi and eastward.

Ceremonial mounds are less easily distinguished. The term should, however, be applied to mounds covering altars, and those which bear evidence of sacrifices, such as have been discovered in the valley of the Ohio and elsewhere. The great Cahokia Mound was probably the site of a temple, and for this reason it, as well as others of this type, may be considered as ceremonial structures.

Domiciliary mounds or platforms are those erected as elevated sites for habitations, or which resulted from the accumulation of camp refuse during a long occupancy. They are met with in Florida and along the low banks of the southern rivers. These often served also as places of individual burials.

The discovery of many objects of European origin in some mounds, more especially those in the southern states; the many references in the works of early writers to the use of mounds by the Indians with whom they came in contact; and the nature of the burials encountered in the northern mounds, which correspond with the known customs of the tribes whose homes were in the neighborhood of these groups, prove that mounds were still in process of erection at the time of the coming of Europeans, but the practise ceased soon after.

The Amazon Expedition of the University of Pennsylvania: GEORGE BYRON GORDON.

The Amazon Expedition was sent out for the purpose of procuring data respecting the relationships of the different tribes in the Amazon valley and in the southern Guianas. The first investigation occupied six months in an unexplored territory between the Guianas and Brazil. Here a number of new tribes were located and extensive data, linguistic and ethnological, were obtained. Each of the tribes was identified as belonging linguistically either to the Arawak or to the Carib stock. On the Ucuyali in the Peruvian Amazon, a number of obscure tribes were similarly studied and their relationships determined. The third region explored was the plain between the Tapajos and Xingu rivers, inhabited by the Mundurucus, whose central villages were visited for the first time by Dr. Farabee, the leader of the expedition.

This latter exploration proves that the great plain above mentioned is a barren waste instead of the fertile grazing land which it was supposed to be. The principal anthropological result of this exploration is the definite identification of the language of the natives with the Tupi stock.

The Ruins of Yucu-Tichiyo: CONSTANTINE G. RICHARDS.

Outside of the places where once stood the palaces of the principal chiefs of the Mixtec and the residence and temples of their priests, namely,

Tilantonge and Achiutla, little is known of the many other ruins found in the Mixtec country. Among these are the ruins of Tucu-Tichiyo. Even here little is now left of what at one time must have been an important center, and the author puts on record some views of the structures before the walls shall all have crumbled and nothing but mounds remain. Remarks were made on the country where the ruins are to be seen, followed by a description of the buildings and mounds still standing. Information from old natives was given, as well as some measurements of the buildings, and what has been found in the course of the limited excavations that have been made.

A Study of Family Names in Chile: Luis Thayer Ojeda.

The present study is composed of four chapters. The first treats of the history of surnames, studying their evolution and their origin from the time when they have merely the form of personal names through to their transformation into generic family names.

The second chapter consists of the etymological classification of family names. From this point of view the author divides the surnames of Chile into seven groups, as follows: Individual, geographic, historic, abstract, combined, doubtful and foreign. The author notes that these groups may be divided and subdivided into related classes.

In the third chapter the author gives the morphological classification of surnames in three groups, as follows: Perfect names, comprising all the Spanish surnames whose orthography is in conformity with that indicated by the Royal Museum; imperfect names, including Spanish surnames which have suffered alterations; and foreign names which embrace all the surnames belonging to other languages.

In the fourth chapter an ethnological classification of surnames is made, arranged by countries in which the names have originated.

In the fifth chapter, after certain considerations, the author arrives at the conclusion that surnames may be an efficient aid in determining the ethnic compositions of countries. The study made of 167,400 names has served as the basis for a calculation of the proportion of the different races which inhabit Chile.

On the Glenoid Fossa of the Eskimo: V. Giuffrida-Ruggeri.

In a recent bulletin of the Canadian Department of Mines, Knowles directs attention to the peculiar form of the glenoid fossa and articular eminence in Eskimo skulls. The fossa is shallow, while the articular eminence is flattened and extended in a forward direction. Having read this notice in *Nature*, June 17, 1915, I immediately wrote to the author, asking for the extract, but up to the present I have received no answer. I think that surely only a small percentage of Eskimo skulls really present such an anomaly, for were it a common conformation it would hardly have escaped notice; but anthropologists who have previously studied collections of Eskimo skulls have never noted the observance of such a peculiarity. On the other hand, this anomaly is not peculiar to the Eskimo, as I remarked on its recurrence, seventeen years ago, in Italian skulls. The publication of my article led to further extensive research in the Anthropological Museum of Florence and a detailed article was published on the subject by R. Polli in 1899.

Mongoloid Signs in Some Ethnic Types of the Andine Plateau: Arthur Posnansky.

A study of certain somatic signs observed by the author in some of the ethnic types of the Andine Plateau, and believed by him to be characteristically Mongolian.

The signs observed are: (1) The Mongolian fold (*pliegue mongolico*) in the countenance of some Indians; (2) the *os japonicum* in certain crania; and (3) the Mongolian spot (*mancha mongolica*).

The author says that it is impossible to determine the percentage of the Indians of the plateau having the Mongolian fold, since there are groups who do not possess it at all, while others show it without exception. Certain tribes of the Chingu River had it in a not very marked degree; but the author has observed it in a more pronounced form in the Paumari and Ipurina Indians on the river Pirûs and on the lower Acre (Brazil). The fold develops as the individual develops, disappearing completely in old age, a phenomenon observed in the Mongolian race also. This characterictic fold is found among the Eskimos, and the Botacudos of Brazil. The author has examined in Europe a thousand crania of Mongolians and an equal number from the pre-Columbian mounds of the Andine Plateau; and in both he found a pronounced *sulcus* in the maxillar or the region of the *procesus frontalis*, and in the *dacryon* (lachrymal region), situated a little above the *piriformis* opening. As this *sulcus* does not appear in anatomical nomen-

clature, the author has called it the *Sulcus Mongolis*. The author believes that the *pliegue mongolico* is motived by the above mentioned *sulcus*, which is found with more or less marked intensity in the crania of the Mongolian races and in some subraces of the Andine Plateau. In the cranium of the European it is so imperceptible that the anatomists up to the present time have had nothing to say about it.

With reference to the *os japonicum* the author says that in a series of 20 crania from Tiahuanacu he found a specimen of the *os japonicum dextrum*. The author has classified this cranium as *dolichocephalic*. A characteristic of this cranium consists in the *procesus marginales dextr. et sinistr.* being greatly accentuated. It is also marked by the persistence of the frontal suture. On account of the lack of facilities, the author was not able to determine the frequency of the *os japonicum* in the crania of the Andine Plateau.

The Mongolian spot (*mancha mongolica*), which has been considered up to the present time as a characteristic mark of the Mongolian race, is found also, according to the writer, with extraordinary frequency on the bodies of Indian children and adults of the Andine Plateau. In certain regions the spot is found in 92 per cent. of the children of pure Aimara (Colla) and Quechua races. The color of the spot is generally purple or greenish blue. It covers the large part of the buttock and extends to both sides of the spine.

Curves of Physical Growth of the School Children of La Paz, Bolivia: GEORGES ROUMA.

This report is composed of five parts, as follows:

The methods used in establishing the curves of growth of the school children, and the importance of its application to the school children of the capital of the republic of Bolivia.

The program which was followed in carrying out the investigations of the physical development of the school children.

The technique employed in the investigations.

A series of graphs showing the results of the measurements taken in La Paz.

General consideration relative to the physical development of the school children of La Paz.

Concepts of Nature among American Natives: ALICE C. FLETCHER.

A broad view of the concepts held by the tribes of this continent makes it evident that to the American natives the cosmos was a living unit, similar to a family, and permeated by a mysterious, unseen, life-giving power which had brought nature into being and provided for its perpetuation through the dual (masculine and feminine) forces. Sky and earth are their simplest representatives. Each section is made up of parts and each part partakes of the function of its section.

Man is not regarded as a distinct creation, but as an integral part of nature, deriving his physical and psychical existence from the same mysterious power that animates all other portions of the cosmos. Many tribes have given this power a specific name which is held in reverence. This power was the object of worship in the tribal rites, in which symbols of animal and psychical forces were widely used, but nowhere did these symbols take on a human form. Tribal rites were primarily religious and were fundamental to the tribal organization which aimed to reflect the concept of the cosmos and man's relation to it. Secular government was subordinate to tribal rites.

To the mysterious power certain human qualities were ascribed, as order, truthfulness, justice, pity. The right to govern was also attributed; the punishment of falsity and wrong-doing. These anthropomorphic ascriptions were never fully carried out and crystallized among the native Americans, as was done on the eastern continent.

The belief that all things were alive and could affect the physical and psychical life of man was also common to both hemispheres. The expessions of this belief on the two continents afford material for an instructive comparison.

Two Notes on Spanish Folklore: G. G. KING.

The author mentions two points of Gallegan use in connection with corn: (1) All through Galicia the granaries are topped with a cross at one end and the ancient emblem of fertility on the other. (2) In August, before the corn is ripe, she found a fresh yellow ear saved from the harvest, hung on a wayside cross.

A variant from Navarre of the folktales of the bird's song that seemed three minutes and three hundred years passed.

Comparative Study of Pawnee and Blackfoot Rituals: CLARK WISSLER.

Since the Pawnee data used in this study are still unpublished, a brief characterization of Pawnee rituals will be given. Then it will be shown that there are very striking parallels between the Blackfoot and Pawnee. This holds both for the rituals themselves and for the bundles with which they are associated. So far as the data for the upper

Missouri village tribes are available, they seem to place them as intermediate between the Pawnee and the Blackfoot. When we consider the distribution of these traits in the Plains area it appears that rituals of the Pawnee-Arikara-Blackfoot type are but weakly developed in neighboring tribes, though strongest among the Siouan neighbors of the Pawnee. Also ritualism is most intense among the agricultural tribes and weakest among those strictly non-agricultural. The suggestion is, therefore, that the Pawnee are the approximate center for the dispersion of this trait in the Plains.

The second peint is a comparison of Pawnee ritualism with tribes in other parts of the continent. We find certain parallels to Pueblo rituals as associated with maize culture and a specific Mexican parallel in the human sacrifice.

A Manuscript by Rasmus Rask: The Aleutian Language Compared with the Greenlandic: William Thalbitzer.

The famous Danish linguist, R. K. Rask, who in 1818–19 stayed at Saint Petersburg on his journey to India, met there two natives of the Aleutian Islands, who had accompanied the expedition of Otto V. Kotzebue on his return from Bering Straits. Rask took the opportunity of recording some specimens of the Aleut language, which he spelled in his usual way and accompanied with a Danish translation, with some additional comparative remarks on the Aleut and Greenland languages. Thus Rask was the first to discover some points of resemblance in the grammar and vocabulary of these languages. This manuscript, which contains about 200 Aleut words, was never published, however, and remained unknown to later explorers of the Aleutians. After the death of Rask, in 1832, the manuscript was deposited in the Royal Library at Copenhagen. It will now be submitted for publication in the *Proceedings* of the Congress, translated into English, being probably the earliest modern contribution to American linguistics made by one of the founders of the present comparative science of languages.

PAPERS PRESENTED FOR WHICH NO ABSTRACT WAS PROCURED

(1) "The Oldest Known Illustrations of South American Indians"; (2) "Present State of our Knowledge of the South American Indians; with a Linguistic Map," by Rudolph Schuller.

(1) "Origin of the Indians of Central and South America"; (2) "Lexicology of the Names of the Indian God," by J. A. Caparo.

(1) "An Inca Road and Several Hitherto Undescribed Ruins in the Urubamba Valley, Peru"; (2) "Some Extraordinary Trepanned Skulls Found this Year in the Urubamba Valley, Peru"; (3) "The Inca Peoples and their Culture," by Hiram Bingham.

"Notes on the Folklore of the Peruvian Indians," by F. A. Pezet.

"The Domain of the Aztecs," by A. M. Tozzer.

(1) "The So-called Pelike Type of North Argentina Pottery"; (2) "Scarifiers of Northwest Argentina," by Juan B. Ambrosetti.

"Cayuga Ownership of New York Land," by Grace E. Taft.

"Eye and Hair Color in Children of Old Americans," by Beatrice L. Stevenson.

"New Methods in Ethnographic Photography," by Frederick I. Monsen.

"What the United States has done for Anthropology," by F. W. Hodge.

(1) "The Pre-Columbian Indians of the Eastern Extremity of Cuba"; (2) "Discovery of the first Indian Sepulture of Cuba," by Louis Montané.

"Observations on Some Shell Mounds on the East Coast of Florida," by Amos W. Butler.

"The Indians and their Culture as Described in the Swedish and Dutch Records of 1614 to 1664," by Amandus Johnson.

(1) "The Diffusion of Culture, a Critique"; (2) "Totemic Complexes in North America," by A. A. Goldenweiser.

"Chronological Relations of Coastal Algonkin Culture," by Alanson Skinner.

"Excavations in the Department of Peten, Guatemala," by Raymond E. Merwin.

"The Rise and Fall of the Maya Civilization in the Light of the Monuments and the Native Chronicles," by S. G. Morley.

"The Archeology and Physical Anthropology of Teneriffe," by E. A. Hooton.

"Early Graves of Nasca Valley, Peru," by Julio C. Tello.

"Origenes Etnograficos de Colombia," by Carlos C. Marquez.

"Archeological Explorations in Mexico," by Manuel Gamio.

"The Racial Factor in Delinquency," by Dr. Thomas Williams.

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ALCOHOL PROGRAM OF THE NUTRITION LABORATORY WITH SPECIAL REFERENCE TO PSYCHOLOGICAL EFFECTS OF MODERATE DOSES OF ALCOHOL ON MAN[1]

ALCOHOL in not too large doses, taken by the mouth, is undoubtedly burned in the body and in this burning gives off heat which replaces equivalent energy ordinarily derived from food or body substance. This has been absolutely demonstrated by Professor Atwater and his associates with the respiration calorimeter at Wesleyan University, Middletown, Conn. This scientific proof of the important rôle that moderate doses of alcohol may play in the human energy economy finds verification in the masterly, statistical studies of Armand Gautier in Paris, who has shown that there are certainly several million people who regularly receive in their daily diet somewhat more energy in the form of alcohol than they do in the form of protein. What has been demonstrated of the French is probably true of many others. Thus we see that a physiological study of alcohol is, on abstract, scientific grounds, essential to a complete understanding of the materials regularly ingested which serve as the sources of energy to the body.

Although protein, fat and carbohydrates have long been studied in a systematic manner, alcohol in recent years has, in spite of the agitation regarding its moral, economical and sociological importance, received but scant, irregular attention in a relatively few scientific laboratories. With regard to its physiological action there

[1] An address given before the New York Academy of Medicine on April 6, 1916.

exists much speculation and a minimum of verified facts. This condition should be reversed, and a great deal of hypothesis which, for the most part, lies outside the realm of probability, should be replaced with a careful series of attested facts obtained under conditions insuring the best available technique, with a sufficient number of subjects and a multiplicity of observations accompanied by controls and normals. Such a procedure is outlined in the program prepared by the Nutrition Laboratory and submitted for criticism to over 400 physiologists, clinicians and psychologists a year or two ago. It is my purpose this evening to bring to your attention this program, its scope, its intentions, and more specifically to present to you in brief abstract the results of our first work on the psychological phase of the alcohol problem.

As the outcome of two extended foreign tours, when the general subject of physiological and psychological research on alcohol was discussed with many scientists, it became evident that:

1. Alcohol investigations are, as a rule, undertaken with diffidence, owing to the fact that relatively few investigators can afford the time or funds necessary to make the observations sufficiently numerous and extended to meet the stringent requirement of critics who, while frequently unscientific, are invariably captious.

2. Objectivity in writing on the subject of alcohol is as rare as uncontaminated scientific evidence.

3. Interpretations of the results of alcohol investigations made outside of the source of experimental evidence have been usually so confused by preconceived ideas of the reader as to lead to the most divergent interpretations of one and the same collection of data. In general an interpretation has been the resultant of scientific record plus the personal, ethical opinions of the reader, with the last named factor usually playing the controlling rôle.

Perhaps these discouragements to vitally needed abstract research on alcohol are after all blessings in disguise; to meet the demands of these adverse conditions tests the mettle of both the experimenter and the writer.

The rapid advances in physiological research, especially in the study of the energy factors both by direct and by indirect calorimetry, the availability of physiological instruments of precision, such as the string galvanometer, sphygmomanometer, electrical resistance recording thermometer, and appliances for the study of muscular work on an accurate basis, and an adequate technique for certain psycho-physiological observations made it seem feasible for the Nutrition Laboratory to begin a study of this general question, with the idea of using its resources and staff in such a manner as to convince all but the most captious of critics of the reliability of the data if not, indeed, of the legitimacy of the interpretation of results. To this end, and especially to secure a working outline which will correlate the immediate and later researches of all laboratories, a somewhat detailed program was planned.

In this program for experimental researches on alcohol the effect of only moderate doses is considered, since the effect of excessive doses with final complete narcosis is obvious. The importance of such a study of the influence of moderate amounts of alcohol is brought out in the introduction of the program.

Furthermore, emphasis was laid upon those points which in previous alcohol investigations had been most severely attacked. Thus, particular attention was given to the size of the dose, the character of the subject experimented upon, the question of repeated versus single doses, the

method of administration, *i. e.*, by mouth and by rectal enema, the time relations between the ingestion of alcohol and of varying foods as well as during fatigue, and the importance of securing adequate controls or base line measurements. This last point was especially emphasized, for in an alcohol investigation controls play as important a rôle as do the alcohol experiments.

A considerable part of the program is given to the general field of physiology, especially those factors which previous experience has shown might react more markedly to alcohol dosage. Studies of the respiration, digestion and secretion, metabolism, and the heat regulation are provided for. Finally, it was believed that since in studies of the metabolism the subjects would normally be under more or less control as to diet and alcohol ingestion, such investigations would provide an excellent opportunity for making simultaneous observations of the psychological effects of alcohol. A section of the program was therefore devoted to a plan for this research. The psychological part of the program was prepared by Dr. Dodge.

It is thus seen that the investigation to be carried out by the Nutrition Laboratory is based upon a carefully prepared program which has been submitted for criticism to a large number of individuals. That it will undergo material modification in the course of time is naturally to be expected, but with this program all completed researches may be correlated and profitable lines suggested for immediate attack.

The material resources of the Nutrition Laboratory of the Carnegie Institution of Washington, located in Boston, made it possible to commence upon this program immediately. The equipment of the laboratory includes several forms of respiration chambers and respiration calorimeters, the latter being placed in a room specially designed for studying heat measurements. Of the calorimeters the one most used is the bed calorimeter which was employed in the prolonged fasting experiment recently reported.[2] It is with these calorimeters that we expect to study many of the problems suggested in the tentative program. A portable form of respiration apparatus has also been developed and extensively employed in studies of the basal metabolism and in other researches in which the gaseous exchange is of special interest. At times no less than four such pieces of apparatus have been used simultaneously in the large respiration calorimeter room.

Without detailing further the equipment of the laboratory which may be used in the general study of the alcohol problem, we may immediately turn our attention to a specific discussion of the psychological section of the alcohol program. As Dr. Dodge was able to concentrate his entire time for a year upon this part of the work at the Nutrition Laboratory, sufficient data have already been accumulated to justify the publication of a monograph[3] on this phase of the subject. This work was carried out at the Nutrition Laboratory chiefly by Dr. Dodge and I should at this point state that when I say "we," I should more properly say "Dr. Dodge."

A special laboratory was prepared for the purpose with darkened walls to facilitate photographic technique and fitted up with psychological apparatus. The chief items of equipment consist of a string galvanometer and accessory apparatus, the electrically-driven Blix-Sandström kymograph, which is of general use, a complete equipment for the determination of the threshold for faradic stimulation (Martin

[2] Benedict, Carnegie Institution of Washington Publication No. 203, 1915.

[3] Dodge and Benedict, Carnegie Institution of Washington Publication No. 232, 1915.

method), and photographic apparatus with suitable luminants for registration of the protective wink reflex and of the eye movements. Both of the special cameras here used were designed by Dr. Dodge. Many other most ingenious devices for studying the problems arising in the course of the development of the psychological program were made by the experimental skill of Dr. Dodge and will be referred to later.

DESCRIPTION OF TESTS

Three fundamental principles determined our selection of the group of experimental measurements:

First, the attempt to secure a group of systematically coordinated measurements.

Second, the principle of relative simplicity, that is, we attempted to investigate elementary neuro-muscular processes in their simplest available form, and of the more complex processes to choose those involving as few unknown factors as possible. In particular we tried to measure processes that were insusceptible to direct and arbitrary conscious modification and as free as possible from uncontrollable influences of bias, effort and attention.

Third, and finally, we attempted to select those processes in which the motor response of the subject would be a thoroughly natural and familiar act, that is, a customary reaction.

The effect of alcohol on a relatively simple neural arc, the patellar reflex, has especial significance to clinicians who have long used it for diagnostic purposes. To render its study most capable of accurate scientific interpretation special apparatus was employed for giving the stimulus, and the latency of the response and degree of contraction of the quadriceps muscle was graphically recorded. The stimulus was given by two pendulum hammers of the same weight so placed as to strike the tendon. By means of a system of light levers fastening directly over the quadriceps muscle, the muscle thickening could be directly recorded on the kymograph and the shock of the impulse blow of the hammer made it also possible to record the moment of stimulus. From the moment of stimulus to the beginning of the rise of the curve, the height could be directly read and the extent of the quadriceps thickening could be obtained by noting the height of the curve and applying a simple factor.

Another simple neural arc which lends itself admirably for study is the protective lid reflex. By projecting a beam of light across the eyelid so that the shadow of an eyelash will fall upon a sensitive plate moving horizontally in a camera, a complete photographic registration showing the moment of stimulus, together with a picture of the lid movement, was obtained. The stimulus was produced by a sounding board struck by two spring hammers, the whole stimulus system having a small pointer whose shadow likewise fell over the camera slit, and thus was simultaneously photographed. As the moving plate was set in motion the stimulus hammers were electrically released and the moment of stimulus and the beginning of lid movement, as well as the height of response, were photographically recorded. It is extraordinarily difficult for a subject to alter the nature of the protective lid reflex or of the knee jerk without this alteration being evident in the records, and we have here, we believe, two indices that give us as nearly uncontaminated data as one could at the present time expect.

Of the complex neural arcs the movement of the eye to a peripheral visual stimulus is one of the common experiences of everyday life. Consequently, by means of the Dodge photographic registration of the movements of the eye, it was possible to record photographically the time required

for the eye to react, *i. e.*, to look over to a new stimulus to the right or to the left of the position which the eye has been occupying. The subject was placed with his eye near the lens of a long photographic camera; a beam of soft blue light from an arc lamp was then projected at will upon the eyeball and reflected through the lens, which focused it to a small point upon a sensitive plate in the camera. The eye looked at a fixation mark; this suddenly disappeared, exposing in an unknown position a single letter which was 1, 2 or 3 centimeters to the right or to the left of the fixation mark. At the moment of exposure the actinic light was allowed to fall upon the eyeball. A tuning fork interrupted the light so that the record consists of a line of dots, each dot representing one hundredth of a second. A bend in the line indicates the moment of reaction, thus giving a photographic record of the latent time as well as the direction of movement.

A second complex neural arc was the reaction time to reading isolated words. With an exposure apparatus of unique advantages 4-letter words were exposed, and the subject was instructed to pronounce each word immediately as soon as he saw it. By means of a voice key with electric contact a record could be made on the kymograph drum of the moment of exposure of the word and the instant of response, thus giving the data for determining the latency of response.

In conjunction with Dr. F. L. Wells, of the McLean Hospital, a series of standard free association tests were given to the subjects. The procedure is so well known as to make a description unnecessary here.

Considerable attention was paid to the effect of alcohol on memorizing, this being one of the higher mental processes. A series of 4-letter words were exposed backwards by attaching to the kymograph drum a piece of paper on which these words were printed. As the drum rotated the last letter of the word appeared first in the window which limited the subject's view, and not until the last letter had in turn appeared could the subject pronounce the word correctly. The words were repeated three times and the saving in time required to repeat the words in order was taken as an index of residual memory. Occasionally subjects could memorize the entire twelve words so as to have a perfect score, pronouncing each word before it was exposed.

The effect of alcohol on the sensory threshold was studied by means of the faradic stimulation method of Martin. This requires a carefully calibrated Kronecker inductorium; the technique has been admirably described by Dr. Martin.[4] Very feeble shocks were produced and the subject, with two fingers dipped in salt solution, was told to indicate when the shock was felt. By moving the coil in and out a threshold could be established. Variations in the position of the coil were the basis of a series of calculations which Dr. Martin has developed, giving the results in the terms of certain units. Since our work is entirely differential, however, it is unnecessary to discuss the character of these units.

No series of observations on the psychological effects of alcohol would be complete without studies of the effect of alcohol on motor coordination. After a considerable amount of preliminary experimentation we decided upon two measurements, the first on the velocity of eye-movements, *i. e.*, in moving the eye from side to side through an arc of about 40°, the second on the reciprocal innervation of the middle finger. The importance of the eye as a member for studying muscular coordination has been

[4] Martin, "The Measurement of Induction Shocks," New York, N. Y., 1912.

emphasized by Sherrington and has been given special attention by Dodge. It is relatively impossible to control voluntarily the rate of moving the eye from one point to another, as this invariably results in an intermittent motion. By having two fixation marks and, on signal, moving the eye as rapidly as possible from one to the other, a photographic record was made of the eye movements. The time is recorded directly on the plate as in eye reaction records, by means of the light interrupter. From this record we count up directly the number of hundredths of a second required for the eye to move through this arc of 40°. This time or velocity measurement is the basis of our discussion. Of course the record indicates the accuracy with which the eye looks at these two marks and also the number of times that the eye moves from mark to mark. This technique has proved most satisfactory.

Since eye movements are not well adapted to show the rapidity of free oscillation, as successive eye movements are separated by moments of fixation, we adopted the reciprocal innervation of the middle finger for measuring the speed of alternating reciprocal innervation of antagonistic muscles. The finger movements were recorded in the following manner:

A very light lever, the weight of which was not borne by the finger, but held by a pivot, was attached to the middle finger of the right hand and the projection of the lever placed opposite the slit of a photographic camera, so that the shadow of the lever could be photographed directly. At the same time electrocardiograms were taken from body leads, thus giving the pulse rate; a respiratory curve and the time in seconds were simultaneously photographed. The number of finger movements during the first, second and third 2-second periods were the basis for discussion. Even in this short time distinct evidence of fatigue was noted.

With these important measurements of simple and complex processes, memory, electrical threshold, eye movements, and finger movements, a large number of pulse measurements were taken throughout the series of observations. After making tests with various forms of apparatus, we finally relied entirely upon electrocardiograms taken from body leads, two electrodes being attached to the chest, thus leaving the subject entirely free and untrammeled for any other simultaneous tests. The electrocardiograms were obviously not taken for diagnostic purposes and have value here as showing only the pulse rate. As the measurements were made not only during the mental work, but during moderate amounts of physical exercise, such as finger movements, rising, and two genuflections, the data obtained permitted us to draw conclusions regarding the heart rate during moderate mental and physical work.

In considering all of our experiments it is important to note that the processes selected for measurement are, we believe, for the most part remote from voluntary or conscious modification or control. The program was quite varied, the subjects passing from one series of tests to another, yet the apparatus was so disposed in the laboratory as to necessitate a minimum amount of extraneous muscular movement in changing from one position to another. Special care was taken to have the whole atmosphere of the laboratory quiet and serene.

SUBJECTS

The problem of collecting subjects for a research of this kind was by no means simple. It was finally decided that a good degree of intelligence was necessary for proper cooperation between subject and experimenter; furthermore, the moral respon-

sibility of giving irresponsible individuals even the distasteful mixtures of alcohol and water was not lightly to be regarded. We therefore decided that only those individuals who were of legal age, and who were college graduates, would be used. Consequently we had approximately ten such subjects and, through the kindness of Dr. E. E. Southard, these were supplemented by a group of three men from the Psychopathic Hospital in Boston to give some indication of the influence of previous excessive use. Our final deductions were drawn from an elaborate series of figures based upon approximately 7 normal and 3 psychopathic subjects, but by far the more extensive series of tests was carried out with the normal individuals.

METHOD OF COMPUTATION

At the outset it was emphasized that an extended series of normal or control experiments was absolutely essential. In fact, we made approximately as many control experiments as we did alcohol tests. This is believed to be good practise as the question of interest, fatigue and the invariably occurring but unforeseen rhythmic and arrhythmic changes throughout any given experimental day must be counterbalanced by control experiments of an extensive nature. Consequently the general method of experimentation was somewhat as follows:

First, the subject was given an entire normal day (about 3 hours) without alcohol. Later this session was duplicated, with a 30 c.c. dose of alcohol. At a third session the dose was raised to 45 c.c. and finally the series was concluded by another control day. In addition to the control tests at the beginning and end of the series, the first period of each alcohol day was given without alcohol, so that we have a "normal of the day," that is, the entire group of measurements for that given day was carried out once before alcohol was given and then subsequently alcohol was administered. The series of observations was repeated several times, depending upon the length of session; usually there were three and sometimes as many as six repetitions on a single day. To allow for the normal daily change, which was invariably noted in all repetition of sessions, we deducted from the "normal of the day" the values found in subsequent series of that particular day; these differences were the basis of our computation. A comparison was then made of differences for the two alcohol days with those for the two normal days; the effect of alcohol was represented by the difference found between the alcohol and the normal days. The statistical treatment of the subject gave us no little trouble; obviously the data permit of any other adjustment or rearrangement that statisticians may deem advisable.

RESULTS OF COMPUTATIONS

Considering only the effect of alcohol with the normal subjects, that is, the difference between the differences found on the alcohol days and those found on the normal days, we note that the latent time of the patellar reflex was lengthened on the average about 10 per cent. In other words, after the stimulus the response in the contraction was delayed approximately 10 per cent. The extent of muscle thickening was enormously reduced, this reduction being, on the average, 46 per cent. In fact this diminution in the muscle thickening was so great as to make it impracticable to conduct the experiment with most subjects after giving the 45 c.c. dose.

The second reflex studied, namely, the protective lid reflex, showed that the latent time was increased 7 per cent., while the extent of lid movement was decreased 19 per cent., a picture perfectly comparable with that of the patellar reflex.

The latent time of the eye reaction, that is, the time elapsing between the disappearance of the fixation point to the movement of the eye appropriate to the stimulus, was increased 5 per cent. In other words, the reaction was distinctly delayed.

In the speech reaction tests, in which the subject was asked to pronounce a word shown in the exposure apparatus, the latent time was increased 3 per cent.

Memory and the free association were only slightly affected. The sensitivity to faradic stimulation was decreased 14 per cent. after alcohol, that is, the threshold was raised, a stronger shock being required to stimulate. In the motor coordinations the number of finger movements in 6 seconds decreased 9 per cent. with alcohol, and the velocity of the eye movement through an arc of 40° decreased 11 per cent., *i. e.*, there was a decrease in velocity both of finger movement and of eye-movement. Thus we see that all the tests thus far show a distinct depressive action of alcohol, a minimum effect being observed in the more highly organized processes, such as memory and the free association.

The large number of pulse observations made during mental work and during moderate physical work showed invariably a relative acceleration of the pulse; this is in striking contrast to the general depression of the neuro-muscular processes at all levels of the cerebro-spinal system. To make this clear, it should be stated that during the sessions of a normal day the pulse rate would tend to decrease with fair regularity from hour to hour. For example, the average pulse rate for the first half hour might be 80 per minute and the rate might decrease until the average for the last half hour would be 62 per minute. On the normal days this picture is very clear. On the alcohol days this decrease is not nearly so large as on normal days. In no instance is the pulse rate higher at the end of the day than at the beginning, but the normal drop does not occur. In other words, we have here distinct evidence of a relative acceleration. Under all conditions of moderate mental and physical work the pulse rate after alcohol did not fall to so low a level as it would have fallen without alcohol.

Summarizing the effect of alcohol we find, then, that the two reflexes showed a distinct lengthening in the latent time of 10 per cent. for the patellar reflex and 7 per cent. for the lid reflex, a decrease in the muscle thickening for the patellar reflex of 46 per cent. and in the extent of the lid movement of 19 per cent.; the sensory threshold was raised 14 per cent.; the two motor coordinations showed a decreased action under alcohol of approximately 10 per cent.; the two elaborated reaction times of the eye and speech organs showed changes of 5 and 3 per cent. respectively, and the memory and free association were unaffected. The natural grouping of these processes is too consistent to be accidental. It is confirmatory evidence of the reliability of our results that similar processes gave similar results. Furthermore in the cases in which there are comparable data it is shown that in 5 out of 6 processes the greater average effect was the result of the larger dose.

It is surprising that the higher processes were apparently not so much affected as the reflexes, but it is significant that the greatest, most persistent change incidental to the ingestion of alcohol is in those processes which are most distinctly exempt from voluntary reinforcement or voluntary control. The higher senses alone show capacity for autogenic reinforcement. This we noted several times in the progress of our experimenting. One most striking illustration was when one of the subjects, during the association test, went to sleep for a

few seconds, and failed to hear one stimulus word; ten seconds later, after being awakened, he responded normally both as to latent time and the character of the associated word. There was a distinct effort in all cases for the subject to attempt to pull himself together to make a showing, but it is a striking fact that in spite of the autogenic reinforcement, with one exception the performance after alcohol was below normal. The one exception was the eye reaction to visual, peripheral stimuli after the 30 c.c. dose, where there apparently seemed to be facilitation as the result of the moderate dose of alcohol. An examination of the data for all the subjects shows, however, that there was a marked practise effect, which was entirely unlooked for in the arrangement of our experiments. But even this could not offset the effect of the larger dose, which invariably showed depression of the reaction.

In the analysis of our data it becomes necessary to consider all sensory and motor processes as the resultant of complex, stimulating and inhibiting factors. It was distinctly noted in our experiments that when there were definite inhibitory processes, such as, for example, in one or two instances where the protective wink reflex was inhibited as the result of training, that this inhibition suffered first under alcohol. This was also noticeable in the threshold for faradic stimulation where alcohol disturbed the subject's caution and produced more numerous false reactions, that is, reactions when there were no stimuli. We have, on the one hand, with the higher senses a capacity for autogenic reinforcement, and, on the other hand, a tendency for the alcohol to affect inhibition. It seems not unlikely that we have here a partial explanation at least for the wide variety of effects which are commonly observed in the social use of alcohol, where environment gives the reinforcement and alcohol reduces the inhibitions. Our evidence is positive, however, that the ingestion of alcohol results in a depression of neuro-muscular processes and that these phenomena can not be reduced to the excitation of the inhibitory processes. But conversely, whenever an apparent excitation occurs as a result of alcohol it is either demonstrably (as in the case of the pulse rate, the reflexes, memory and the threshold) or probably (as in the eye reaction) due to a relatively overbalancing depression of the controlling and inhibitory processes.

The most apparent exception to the general trend of depressions noted in all the processes was that of the pulse. A careful analysis of individual pulse cycles showed, however, by the method of Reid Hunt, that there are large variations in the length of diastole after alcohol. Since many of our experimental observations were made in relatively short periods, it appeared logical to assume that the changes in pulse rate were due not to the stimulation of the slow-acting accelerating mechanism, but to the rapidly reacting inhibitory mechanism. We may therefore explain this apparent relative acceleration of the pulse rate on the ground of a partial paralysis of the cardio-inhibitory mechanism.

It is also of interest to note the time of the maximum effect of alcohol in the various processes. In general there was a remarkable uniformity in the time after the ingestion of alcohol when the greatest effect was noted. This was practically from 90 to 100 minutes, in other words a little over an hour and a half, and essentially constant for all the processes.

Finally, to note if there was a central tendency in any one of the particular series of measurements we compared the average effect of alcohol upon each process for the individual subjects with the average for the

group and found that the average effect was closely approximated by the effect upon the motor coordinations, *i. e.*, finger movement and eye movement. Aside from the practical value of this correspondence between the effects of alcohol on the coordination processes and the average effects, it has a rather far-reaching, theoretical implication. If, in all the diverse processes that we have measured, the coordination processes represent a central numerical tendency, it must be that they correspond in some closer way than the rest to the real central tendency of the alcohol effect. It would seem to indicate that the change in the average performance of our subjects due to alcohol was a function of central coordination. If this indication is substantiated by later investigations it should prove to be not only of the utmost importance for the understanding of the various manifestations of the effects of alcohol in individual cases and of the general phenomena that accompany its excessive use, but it would throw a flood of light on the complex organization of normal psychophysical processes as well as on the effects of fatigue and other depressing agents.

In reporting these results I feel that the techniques outlined above have been adequate to this type of problem, that the controls have been satisfactory, and that the data and interpretations have been presented with the least amount of personal bias that is possible to scientific investigators. But naturally these results must not be considered as having settled the alcohol problem as regards the psychological effects of small doses. As all present know, the literature in this field is very large and there are numerous contradictions in results and interpretations. It is very rarely possible for one investigator to duplicate the apparatus, methods and general conditions of another. This is doubtless one of the main causes for confliction. We therefore feel that one of the important contributions to our program and scheme of work on the alcohol program should be the continued massing of data over a period of years. It is also advisable that the data should not be collected by one experimenter. If two experimenters, both carefully trained, and thoroughly familiar with the same group of methods should use these methods on a different set of subjects, but under similar laboratory conditions, comparisons of these two sets of results should be of great importance. If they are opposed to each other, it is a good index of unknown or uncontrolled factors in the problem, insufficient data, carelessness of technique, or wrong statistical treatment. On the other hand, should these results confirm each other in the main, and especially if both groups of data are fairly large, this confirmation should place these results upon a plane which is unique in the annals of alcohol experimentation.

It will doubtless be considered of enormous practical significance that in none of our data have we any indication of the pure facilitation effect of alcohol. Contrary to the theory of Kraepelin, we not only found no facilitation of the motor processes, but the depression of the simplest forms in the finger and eye-movements seems to be one of the most characteristic effects of alcohol. Certain it is that, in conjunction with the pulse acceleration, the general neuro-muscular depression may be regarded as presumptive evidence of the effect of alcohol on organic efficiency. It is, however, of vital importance in seeking to transfer the results of such laboratory demonstrations as have been here reported to a general consideration of alcohol on industrial efficiency to recall that the higher central processes by reason, we believe, of autogenic reinforcement showed the least effect. Indus-

trial processes are by no means solely confined to motor coordination, and I must emphasize that the data of this report may not be uncritically applied to industrial situations. More complex processes, such as typewriting, which seem to apply more directly to industrial environment, are being studied, and their various factors analyzed by my colleague, Dr. Walter R. Miles, experimental psychologist of the Nutrition Laboratory. It is only upon the basis of such analysis that justifiable conclusions may be made with regard to the effect of alcohol upon the mental and physical demands of industrial environment.

It may be added that the material already published is being further elaborated, both experimentally and statistically, by Dr. Miles.

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CINCHONA AS A TROPICAL STATION FOR AMERICAN BOTANISTS

IT is now practically assured that some fourteen American universities, botanical foundations and individual botanists are to cooperate with the Jamaican government in the support of Cinchona as a tropical station. A move to aid in the support of Cinchona, initiated by the Botanical Society of America in 1912, was not consummated, in consequence of the earlier leasing of the station to the British Association for the Advancement of Science. The Jamaican authorities and the British Association seem quite willing, under present conditions, to allow the lease to pass into American hands after October next.

The attention of American investigators should, therefore, be directed to the facilities for botanical research offered by this oldest and best known botanical laboratory in the western tropics.

A brief description of the location of Cinchona and of its botanical environment has recently appeared in *The Popular Science Monthly* (December, 1914, January, 1915). Among the advantages of this station for American botanists there enumerated are the greatly varied flora and series of types of vegetation; the proximity of a library and of two other botanical gardens, beside that surrounding the laboratory. The location of Cinchona is a very fortunate one for American botanists from a practical standpoint. It is in an English-speaking country with good roads, a stable government and adequate quarantine service. It is also within easy reach of our eastern seaports, from several of which the round trip to Jamaica and Cinchona can be made in summer for $75.00 or less for transportation.

In order to give a more adequate idea of the advantages of Cinchona for several different types of research I have asked four investigators who have worked there to suggest the opportunities presented at Cinchona for research in the four or five lines which they have followed. These outlines are appended under the names of their respective authors.

It is altogether probable that any American botanist wishing to work at Cinchona during the coming summer will be granted the privilege by requesting it of the colonial government of Jamaica through Superintendent William Harris, F.L.S., Hope Gardens, Kingston, Jamaica. The writer and the authors of the appended notes on the botanical opportunities of Cinchona will be glad to give any information, within their knowledge, of conditions at and about the laboratory.

DUNCAN S. JOHNSON
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BALTIMORE,
May 25, 1916

THE FERN-FLORA OF CINCHONA

THE writer has visited a good many regions rich in ferns, but none equals Jamaica either in number of species or individuals. The extraordinarily varied conditions in Jamaica, due largely to its topography, result in a variety of the fern flora which is really amazing. About five hundred species are reported from this small island, of some four thousand square

miles in extent—a number much exceeding that of the whole of North America north of Mexico.

The high rain forest of the Blue Mountains in the neighborhood of Cinchona, is especially rich in Pteridophytes and Hepaticæ, and offers very exceptional opportunities for collecting material of a great variety of interesting ferns, especially many types which are quite unrepresented in the United States, or at best are represented by a very few extremely rare species.

The very important order, Marattiales, entirely absent from the United States, is represented by species of *Marattia* and *Danæa*, abundant and easily collected. The beautiful filmy ferns, Hymenophyllaceæ, abound and comprise numerous species of *Hymenophyllum* and *Trichomanes*.

Tree ferns of the genera *Hemitelia, Cyathea* and *Alsophila* are very abundant, sometimes 30–40 feet in height, and the Polypodiaceæ are represented by an enormous number of species. The Gleicheniaceæ and Schizæaceæ are better developed at lower elevations, but may be procured without much trouble.

Numerous species of *Lycopodium* and *Selaginella* are common, and at lower elevations in the Blue Mountains one sometimes finds thickets of *Equisetum giganteum*, ten or fifteen feet high.

In the neighborhood of Cinchona—and indeed all over the island—the Hepaticæ are very abundant, and include many rare and interesting forms, which can not be given here in detail.

Douglas Houghton Campbell
Leland Stanford Jr. University

Lichens and Bryophytes at Cinchona

The region around Cinchona is remarkably rich in Bryophytes and Lichens. Even in the immediate vicinity of the station excellent collecting grounds are available, such as the trees behind the laboratories, the trail to and through Morce's Gap, and the trail to Newhaven Gap. More distant points, such as John Crow Peak, Sir John Peak, Mabess River and Doll Wood, yielded additional species in great variety and can be visited without difficulty.

From the standpoint of the Hepaticæ, to which the writer devoted particular attention during his two visits to Jamaica, the epiphyllous species and the distinctly tropical genera are perhaps the most striking and interesting. Most of the epiphyllous forms belong to the Lejeuneæ and include the genera *Odontolejeunea* and *Leptolejeunea*, together with species of other genera. In addition to the Lejeuneæ the tropical genera *Symphyogyna, Tylimanthus, Syzgiella, Isotachis* and *Dendroceros* are well represented, and many genera known in northern regions by a single species or by a small number of species here attain a remarkable luxuriance. This is strikingly true of *Plagiochila, Lepidozia, Bazzania, Frullania* and *Anthoceros*. Other northern genera, such as *Gymnomitrium, Marsupella, Jungermannia* and *Lophozia*, are either absent altogether or very sparingly represented.

The student of taxonomic problems soon becomes impressed by the imperfection of our knowledge of tropical species and by the difficulties of interpreting the older records regarding them. It will, in fact, be a very long time, unless the number of workers becomes much greater, before our knowledge can even approach completeness. The study of tropical Bryophytes involves careful work in the field followed by careful study in the laboratory and herbarium, and the facilities offered at Cinchona and Hope Gardens are probably unequalled anywhere else in the tropics except at the botanical garden of Buitenzorg.

A. W. Evans
Yale University

Cytological Material at Cinchona

The region about Cinchona offers many advantages to one desiring material for cytological study. The flora is so varied and profuse that the student of almost any group of plants will there find valuable material. This is notably true of lichens, liverworts, ferns and flowering plants. Much light is frequently thrown on perplexing cytological problems by the study of related genera and species; and

thus to one whose investigations have been confined to those species growing in the temperate zones, Cinchona furnishes splendid opportunity for the extension of his work to such allied tropical species.

A tropical rain-forest presents peculiar conditions. The plants do not show the marked periodicity characteristic of colder and dryer regions. Where the temperature and rainfall are so nearly constant at all times of the year as at Cinchona, one is likely to find all of the stages in the life history of a species on almost any single day, and conditions are favorable for collecting the year around. In the plants of a tropical rain-forest, moreover, there is much less cutin, fewer hairs, etc., to interfere with the penetration of fixing solutions, and hence there is the probability of better fixation. That such is not in all cases true is evidenced through the impermeability of the walls of fern sporangia, and the hairiness of the leaves of the Gymnogrammeæ may be as striking here as elsewhere.

To the cytological collector a compound microscope is an absolute necessity; and such a permanent station as that at Cinchona, therefore, seems to be the only solution to the accessibility of such regions. The buildings at Cinchona, including two cottages, a two-room laboratory, the drying house, the dark room, the greenhouses and the garden, were all in good condition when I left there in December last. Through the kind offices of Mr. William Harris at Hope Gardens servants were made available, and one's personal needs adequately supplied. The space is sufficient for a number of investigators at one time, and life there is very pleasant indeed. C. H. FARR

COLUMBIA UNIVERSITY

EXPERIMENTAL WORK AT CINCHONA

THE portions of the Blue Mountains which are accessible from Cinchona, at both higher and lower altitudes, exhibit a diversity of vegetation in correlation with the widely differing temperature and moisture conditions, and also a vertical diversity from floor to canopy within the rain-forest itself. Ample opportunity is thus offered for the investigation of the physical environment in relation to the local and general distribution of plants. A wide range of plant material is available for the study of general physiological behavior as well as for the special types of activity characteristic of rain-forest plants. The fundamental processes of plants, as carried on under extremely humid conditions, and the influence of the character and rate of these processes upon the growth, distribution and periodic phenomena of the hygrophytic vegetation offer a rich field for future work at Cinchona. The gardens, greenhouses and various outbuildings afford opportunity for propagating plants and for placing them under a variety of experimental conditions. The nearness of an extensive tract of virgin forest is also a valuable asset for physiological as well as ecological work. The excellent trails, the easy means of communication and supply, the presence of a guide with a knowledge of the local flora, and the very healthful living conditions combine to make Cinchona an extremely useful station for those who may wish to carry on more or less prolonged investigations in the problems of the semi-torrid and humid tropics.

FORREST SHREVE

THE DESERT LABORATORY

UNIVERSITY AND INDUSTRY[1]

1. THIS Committee was appointed at the April, 1916, meeting to consider the papers presented at the meetings in November and December, 1915, and in April, 1916, and to report at the June, 1916, meeting; this report to embody the findings, conclusions and recommendations of this committee based upon the foregoing material, supplemented by such other as this committee was able to consider.

2. Your committee was divided into three subcommittees to examine the above subject-matter from three different points of view: Firstly, that of the university; secondly, that of the industries, and thirdly, that of the consulting chemists. Each of these subcommittees reached its conclusions separately and these conclusions were then submitted in writing to the full committee. The work of the whole committee is given in the following under

[1] Report of a committee of the New York Section, American Chemical Society.

three headings, namely: Findings, Conclusions and Recommendations.

FINDINGS

(*a*) Research is the source of all added knowledge.

(*b*) The universities are properly institutions of research.

(*c*) The proper development of university research requires unlimited and unrestricted publicity as to all its activities and results.

(*d*) Not all research activities of the industries can be published and it is only in such cases where publicity is compatible with industrial progress, that full cooperation between the universities and the industries can be effected.

(*e*) When a faculty-member as an individual works in conjunction with an individual industry and the results of that work are kept secret, that is not that cooperation between universities and industries which this committee is considering.

(*f*) Industrial or similar fellowships when founded by industrials or groups of industrials, coupled with publicity of the results, are effective modes of cooperation; the effectiveness of these fellowships diminishes as the number of contributing industrials decreases and the liberty to publish is restricted.

(*g*) In the case of problems of the industries where the results shall be held exclusive or secret or subject to patent, no general solution can be offered, but in each such case the individual industrial and the individual faculty-member or the individual institution must work out the best plan under the given set of conditions.

(*h*) No matter how efficiently the university may train its men, the industries that take up such men must be prepared to expend considerable of their own time, effort and money in training such men for the specific work before them.

(*i*) The tuition and fees paid by students cover only a small part of the cost of their education at the universities.

(*j*) Apprenticeship of chemists during summer vacations in the industries is not in general feasible, and in general is limited to routine experience in the analytical laboratory and not in the manufacturing plant proper.

(*k*) Scientific problems and the scientific side of technical problems are proper subjects for university treatment and investigation; the bringing of the university professor into the industries by having him examine the problem in the plant and determine the scientific aspect of the problem, and the pursuit of that problem in the university, is a promising point of entry for increased cooperation.

CONCLUSIONS

I. Cooperation, such as has been had heretofore, between associations of industries and institutions of learning for the solution of scientific problems or the scientific side of industrial problems, which are common to such specific industries, and the appropriate publication of the results of such investigations, has been productive of great public good, and the greatest immediate prospect for expansion of cooperation between universities and industries lies in coordinated effort along the above lines.

II. There are industrial problems not common to any group or number of plants and which can not properly be published, and these are, therefore, not adapted to university treatment; problems of this kind in the course of time do become common to the entire industries; to increase cooperation in this class of problems it is needful to accelerate the transfer of problems of this class to problems of the preceding class.

III. In order that there may be as little duplication of effort and labor as possible, and the greatest acceleration of cooperation, a permanent central committee should be created and appointed by representatives of the universities and the industries, and such committee should study opportunities and make public recommendations for cooperation along the lines laid down in these conclusions.

IV. Cooperation between universities and industries as to uniform requirements in the fundamentals of instruction seems possible, feasible and mutually profitable.

V. Such universities as aim to produce technical men should equip them with a working acquaintance with the fundamental types of machinery likely to be used in actual practise.

VI. In order to increase opportunity for research on the part of qualified faculty-members, relief from routine and administrative work within the university should be encouraged and executed to its reasonable limit.

VII. Our universities have a training capacity for branches of industry not now existent in this country; such unexploited training opportunities should be published by the universities to the end that our industrials and others might take up the advisability of creating such non-existent industry.

VIII. The industries can stimulate research by publishing such specific problems as may be common to the industry and yet not of sufficient importance to the industry to undertake their solution directly; such problems would afford valuable training for students and give them live material upon which to work.

IX. The industries, through associations and otherwise, when submitting problems for research, would facilitate the work if they were to make reasonable provision for the financial reimbursement of the university for its expenditure of time, effort and material, and thereafter provide for suitable stimulus and encouragement for expansion of cooperative effort, such as endowments, fellowships and the like.

RECOMMENDATION

In view of the foregoing, this committee is unanimous in recommending that the American Chemical Society take the initiative in creating the committee suggested in Conclusion III.

Respectfully submitted,

CHARLES BASKERVILLE,
Chairman
W. S. ALLEN,
VIRGIL COBLENTZ,
GEO. A. HULETT,
E. G. LOVE,
RUSSELL W. MOORE,
MAXIMILIAN TOCH,
J. C. OLSEN,
F. G. WIECHMANN

DR. UGO SCHIFF

THE recent death of Dr. Ugo Schiff, professor of chemistry in the Royal Institute of Florence, recalls to mind that historical meeting of chemists which convened in Karlsruhe in 1860. The classical work of Stas on atomic weights published about this date had caused much discussion as to the real significance of these constants. There was, however, no uniformity in regard to the choice of equivalents, with the result that great confusion existed in the selection of formulas of compounds. Thus the formula for even so simple a substance as water will be found in the writings of the chemists of this period designated variously as H_2O, H_2O_2 and HO, while the more complex compounds were sometimes represented by a score or more of different formulas. In order to discuss this unfortunate situation and with the hope that some system might be brought out of the chaotic condition, Kekulé and a few of his associates called a meeting of the great chemists of Europe. This meeting convened in Karlsruhe in 1860. It was here, after much discussion, that Cannizzaro delivered that now justly renowned address in which he pointed out that all confusion would disappear if we but accept in its entirety the hypothesis advanced by his fellow countrymen, Avogadro and Ampere. The address was published in pamphlet form and distributed among the chemists present. The effect of the address may be judged from the following quotation[1] from Lothar Meyer:

> I too got a copy which I put in my pocket to read on my home journey. I read it again and again and was astonished at the light which the writing threw on the most important points at issue. The scales fell from my eyes, doubt vanished and a sense of the calmest certainty took its place.

For a number of years preceding his death Schiff was the only living representative of that remarkable body of men who attended this conference. The mention of his name to any of the chemists in Europe was almost certain to bring the reply that he was the only

[1] Armitage, "A History of Chemistry."

chemist living who had attended the famous meeting at Karlsruhe in 1860.

I chanced to visit Professor Schiff's laboratory at Florence in 1913 and found him a delightful gentleman, who, although over eighty years of age and suffering greatly from the gout was still able to give his course of lectures. He spoke with feeling of his friendship for some American chemists, especially for the late Professor Caldwell, of Cornell University, whom he had met while the two were students together in Woehler's laboratory at Göttingen.

Professor Schiff was a German and educated in German universities. He was compelled to leave his native land, however, because of his rather advanced political views and went some forty years ago to the Royal Institute of Florence, where his brother was professor of physiology. Professor Schiff made numerous contributions to chemistry and was the discoverer of the compounds known as Schiff's bases. He had no use for physical chemistry and would not allow the use of electricity in his laboratory. This recalls the fact also that Professor Baeyer's laboratory at Munich did not include any laboratory devoted to physical chemistry until 1913, when a small room was fitted up for this work.

William McPherson
Ohio State University

SCIENTIFIC NOTES AND NEWS

Dartmouth College has conferred the degree of doctor of laws on Ernest Fox Nichols, retiring president of the college, who has resigned to accept a chair of physics at Yale University.

Dr. William H. Welch, professor of pathology at Johns Hopkins University, received the honorary degree of doctor of laws from the University of Chicago at the commencement exercises.

Yale University has conferred its doctorate of science on Dr. Theobald Smith, of the Rockefeller Institute for Medical Research, and the degree of master of arts on Professor A. D. Bevan, of the Rush Medical College.

In conferring degrees of doctor of science and master of arts, respectively, at the Harvard University commencement exercises, President Lowell said:

> Richard Pearson Strong, knight errant of these latter days, armed not like the knights of old, but with the power of science, yet running greater risks than they; destroying dragons invisible to mortal eye, and saving not one or two, but hundreds and thousands by his art.
>
> Ernest Henry Wilson, a botanist, who has explored the flora of the Chinese-Tibetan land, and enriched with many Asiatic shrubs and trees the gardens of the western world.

Dr. Harmon N. Morse, professor of chemistry in the Johns Hopkins University, has received the doctorate of laws from Amherst College, from which he graduated in 1873.

The degree of doctor of science was conferred on Dr. Ludvig Hektoen, director of the Memorial Institute for Infectious Diseases, Chicago, by the University of Wisconsin, at the commencement on June 21.

The honorary degree of doctor of science was conferred on John J. Carty, of New York, chief engineer of the American Telephone and Telegraph Company, at the commencement of Bowdoin College.

Dr. Edward J. Nolan was given the degree of doctor of science by Villanova College at the last annual commencement, in recognition of his many years' service as librarian and secretary of The Academy of Natural Sciences of Philadelphia.

At the recent commencement the University of Pittsburgh conferred the honorary degree of doctor of laws on Dr. Otto Klotz, Dominion astronomer, Ottawa.

Dr. N. A. Cobb, of the Department of Agriculture, has received from the National Association of Cotton Manufacturers a medal "for his work in establishing methods of determining the properties and value of cotton."

On King George's birthday many titles were conferred, among them that of knight on the following scientific men: Dr. G. T. Beilby, F.R.S., the chemist; Dr. M. A. Ruffer, formerly professor of bacteriology at Cairo Medical

School; Dr. J. J. H. Teall, F.R.S., late director of the Geological Survey of Great Britain; Mr. R. F. Stupart, director of the Meteorological Service of Canada, and Dr. N. Tirard, medical editor of the "British Pharmacopœia." Dr. W. Baldwin Spencer, F.R.S., professor of biology in the University of Melbourne, was made a K.C.M.G. and Dr. Christopher Addison, parliamentary secretary to the ministry of munitions, and late professor of anatomy in the University of Sheffield, a privy councillor.

PROFESSOR ARTHUR SCHUSTER, honorary professor of physics at Manchester, has been appointed Halley lecturer at Oxford.

AT the meeting of the British Association to be held at Newcastle-upon-Tyne, beginning on September 5, evening lectures will be given by Professor W. A. Bone, F.R.S., on "Recent Advances in Combustion," and by Dr. P. Chalmers Mitchell, F.R.S., on "Evolution and the War."

DR. CHARLES HORACE MAYO, of Rochester, Minn., was elected president of the American Medical Association at the recent Detroit meeting. Dr. William J. Mayo, his brother, was president in 1906.

THE National Society for the Promotion of Engineering Education held its annual meeting at the University of Virginia from June 19 to 22, under the presidency of Professor Henry S. Jacoby, of Cornell University.

AT the annual meeting of the Eugenics Research Association held at Cold Spring Harbor on June 22, Professor Adolf Meyer was elected president in succession to Professor J. McKeen Cattell. The association will join in the Convocation Week meeting of the American Association in New York at the end of the present year.

FRANCIS C. SHENEHON, for the past seven years dean of the college of engineering and professor of civil engineering in the University of Minnesota, has tendered his resignation to the board of regents. Mr. Shenehon will devote his entire time to his practise as a consulting hydraulic engineer.

PROFESSOR CHAS. H. TAYLOR, head of the department of geology in the University of Oklahoma for the past five years, has resigned, to devote himself to his oil interests and to scientific research.

DR. A. D. EMMETT, assistant chief in animal nutrition, of the Illinois Agricultural Experiment Station at the University of Illinois, has accepted the position of research biological chemist in the research laboratory of Parke, Davis and Company, Detroit, Michigan.

PROFESSOR CALVIN O. ESTERLY, of Occidental College, is to go to the Scripps Institution for Biological Research of the University of California at La Jolla, as zoologist.

DR. FRANK E. LUTZ, of the American Museum, and Mr. J. A. G. Rehn, of the Philadelphia Academy of Natural Sciences, plan to spend July and part of August making a field study of the insect fauna of the isolated mountains southwest of Tucson, Arizona.

To study the return of plant life on an Alaskan volcano, Professor Robert F. Griggs, of the department of botany of the Ohio State University, accompanied by his family, left recently for Mt. Katmai, a volcano near the western coast of Alaska. The eruption of the volcano four years ago destroyed every vestige of plant life in the vicinity.

EDWARD P. VAN DUZEE has resigned his instructorship in entomology at the University of California, to accept the appointment of curator of the department of entomology of the California Academy of Sciences.

DR. JOSEPH A. LONG, assistant professor of embryology in the department of zoology, University of California, has been granted a year's leave of absence. He plans to remain in residence in the laboratories of the department of anatomy in order to continue certain researches on the ovulation of mammals and the earliest development of the mammalian ovum in conjunction with Professor Herbert M. Evans.

IN connection with the Quarter-centennial Celebration, held at the University of Chicago, June 2–6, 44 of the 82 doctors in botany returned to the departmental conference. At the formal conference, the papers representing

the doctors were as follows: "Genetical Phenomena in *Œnothera*," George H. Shull (1904), Princeton University; "A Quarter-century of Growth in Plant Physiology," Burton E. Livingston (1901), Johns Hopkins University; "The Problems of Plant Pathology," Frank L. Stevens (1900), University of Illinois, and "Inland Associations of Algæ and their Controls," Edgar N. Transeau, Ohio State University.

At the University of Illinois College of Medicine, Chicago, during the graduate summer quarter (June 20–September 12), in addition to the scheduled courses, a series of lectures will be given before the faculty and students to which physicians and all others interested are especially invited. The series will include about twenty lectures upon special research topics in the preclinical sciences by men from various institutions throughout the country. The opening of the graduate quarter will occur on June 20 and the first lecture of the series will be given on that date at 11 A.M. by Dr. Frank Billings, his subject being "The Relation of Graduate Work in the Fundamental Sciences to Clinical Study." President James will preside and will give an introductory address on "Graduate Work in Medicine."

Sylvanus Phillips Thompson, professor of physics in the Finsbury Technical College, London, known for his contribution to physics and electrical engineering, died on June 13, aged sixty-five years.

We learn from *Nature* of the death of M. Paul Lemoult, until the outbreak of war professor of chemistry at the University of Lille, and director of the School of Commerce of the North, and chief engineer of the chemical works of La Pallice, near La Rochelle. When Lille was occupied by the Germans some of the industries were transferred to the Lyons district, and under the direction of Professor Lemoult a picric acid works was erected. On May 1, a fire broke out in the works, and very soon assumed serious proportions. Lemoult was soon on the spot, but, in spite of his efforts, the fire spread to the storehouse, which contained 150 tons of picric acid. The explosion which ensued destroyed the factory, and Lemoult lost his life.

Two members of Lord Kitchener's party, who were lost with him, were Sir H. F. Donaldson and Mr. L. S. Robertson. Sir Frederick Donaldson was chief technical adviser to the ministry of munitions. He was president of the Institution of Mechanical Engineers in 1913. Mr. Leslie S. Robertson, assistant to the director of production in the ministry of munitions, was secretary of the Engineering Standards Committee.

The lectureship in animal embryology at the University of Cambridge will not be filled now, the balance of the benefaction (about £300) accruing since the death of Dr. Assheton, the late lecturer, being applied to completing and publishing the embryological work on which he was engaged.

Addresses at the dedication of the Van Vleck Observatory at Wesleyan University on June 16 were made by Dr. George Ellery Hale, director of the solar observatory of the Carnegie Institution, on "Astronomical Research as National Service," and by Professor Edward Burr Van Vleck, of the University of Wisconsin, on "John Monroe Van Vleck." The tablet on the building bears the inscription:

> This Observatory, the gift of Joseph Van Vleck, commemorates the services rendered to Wesleyan University 1853–1912 by his brother John Monroe Van Vleck, professor of mathematics and astronomy.

A tablet was unveiled on June 20 to the memory of Dr. Leonard Pearson, formerly professor in the University of Pennsylvania veterinary school and dean of the faculty. The exercises were held in the library of the veterinary school. Addresses were made by Dr. Louis A. Klein, dean of the veterinary school; Dr. William H. Caldwell, secretary of the American Guernsey Cattle Club, and Dr. C. J. Marshall, state veterinarian. The tablet was presented on behalf of the Guernsey Breeders' Association by Dr. Ephriam T. Gill, and was accepted for the university by Provost Smith. The tablet reads: "To the memory of Leonard

Pearson, B.S., V.M.D., M.D., eminent as a veterinarian, scholar and lover of mankind, through whose breadth of vision and untiring efforts these buildings were made possible; whose appreciation of the needs of animal husbandry kept him in sympathetic touch with the farmer, and whose achievements will always be an honor to his alma mater, this tablet is affectionately dedicated by the Guernsey Breeders' Association."

THE will of Mrs. Helen C. Julliard gives $50,000 to the American Museum of Natural History, $25,000 to Colorado College, $100,000 each to St. John's Guild and the Lincoln Hospital, and $50,000 to the New York Orthopedic Hospital.

THE Guggenheim brothers, associated as M. Guggenheim Sons and Co. and in the American Smelting and Refining Company, have added $165,000 to their donations to Mount Sinai Hospital, making their total gifts in memory of their parents $665,000.

ANNOUNCEMENT is made of a gift to the Johns Hopkins Hospital of the sum of $95,000 by Dr. Kenneth Dows, of New York. The money is to be devoted to the investigation of tuberculosis and the better teaching of physicians and students in the recognition and management of the disease and the care of the patients who seek treatment for it at the hospital.

UNIVERSITY AND EDUCATIONAL NEWS

MEMBERS of the Du Pont family, who are alumni of the Massachusetts Institute of Technology, have given $800,000 for the extension and maintenance of the new buildings. Four other alumni—Charles Hayden, C. A. Stone, E. A. Webster and Edward B. Adams—have subscribed sums amounting to $200,000. It is understood that the anonymous donor who has already made large gifts to the institute has undertaken to give five dollars for each three dollars subscribed by the alumni during the present year.

IT is planned to hold the annual meeting of the American Association of University Professors in New York City on Friday and Saturday, December 30 and 31. Further details will be published in the October number of the *Bulletin* of the association.

DR. WALTER EUGENE GARREY, for some time connected with the department of physiology of the Washington University, St. Louis, Missouri, has been elected to the chair of physiology in the college of medicine of Tulane University of Louisiana.

PROFESSOR JAMES F. NORRIS, head of the department of chemistry at Vanderbilt University, Nashville, Tenn., has resigned to accept a professorship of general chemistry at the Massachusetts Institute of Technology. He will be immediately associated with the instruction to be given in the fourth and fifth years of the new course in chemical engineering just established. Professor Frank H. Thorp, of the institute, has resigned his assistant professorship of industrial chemistry, and expects to devote himself in the immediate future to private business.

DR. ROSS AIKEN GORTNER, from 1909 to 1914, resident investigator in biological chemistry at the Station for Experimental Evolution of the Carnegie Institution and since that time associate professor of soil chemistry in the division of soils of the University of Minnesota, will transfer, on August 1, to the division of agricultural bio-chemistry in the same institution, with the title of associate professor of agricultural bio-chemistry, in charge of the section of bio-chemical research.

LESLIE ALVA KENOYER, Ph.D. in botany from the University of Chicago, has been appointed to a professorship in biology at Ewing Christian College, Allahabad, India, and is sailing from Vancouver on June 29.

DISCUSSION AND CORRESPONDENCE

THE ACCEPTED FACTS OF DYNAMICS

OF those who have contributed to the recent discussion in SCIENCE concerning the methods of presenting the laws of dynamics, all would

undoubtedly solve actual problems with accordant results. If this is true it is evident that the disagreement is largely a matter of words rather than of principles, and that if all understood one another a large part of the apparent disagreement would vanish. Most of us find it difficult to give the same careful consideration to propositions advanced by others that we expect them to give to our own. The habitual use of a certain routine tends to give the mind a "permanent set" which makes it difficult to appreciate the fact that equal familiarity might prove another routine to be equally effective. One who is strenuously opposed to a particular method will find it a useful exercise to adopt that method temporarily and apply it to actual problems in sufficient number and variety to make him thoroughly familiar with it.

I have not the slightest doubt that the routine favored by Mr. Kent[1] can be used effectively in teaching students to state correctly the solutions of problems in uniformly accelerated motion. Neither have I any doubt that the method outlined by me[2] can be used with equal effect. In the explanation of the fundamental equation the two methods are in fact identical, except as regards the matter of the choice of units. Mr. Kent apparently believes that the adoption of a particular set of units[3] is essential to the success of his method, while I believe it to be important to emphasize the fact that the choice of units is arbitrary and that Mr. Kent's units are no more easily understood than other systems which are in common use. To define units so that *unit force would give unit quantity of matter an acceleration of 1 foot per second per second* seems to me to be as simple and as easily understood as the definition *unit force is the force which would give unit quantity of matter an acceleration of 32.1740 feet per second per second.* The two definitions are based upon the same fundamental principle, and it would seem that a very effective method of helping the student to grasp the real significance of this principle is to give him plenty of practise in applying both definitions and in reducing forces and quantities of matter from one unit to another.

The chief remaining difference between Mr. Kent and myself is a verbal one: It seems to me undesirable (because obstructive of clear thinking) to designate two distinct physical quantities such as "quantity of matter" and "earth-pull" by the same name when there is an easy way to avoid it; but I have no expectation of converting Mr. Kent to my opinion on this point.

The method advocated by Professor Huntington can also without doubt be made effective if used with due persistence by an enthusiastic teacher like himself. The peculiar feature of this method is that it purports to be independent of mass. The eleven propositions which embody the latest presentation of the method[4] are in fact free from any adequate explanation of mass; but until the omission is supplied the sufficiency of these propositions can not be granted. The question of their sufficiency may be put to a simple test: Do they suffice for the solution of problems like the following:

A certain body has an acceleration of 10 ft./sec.^{2} when acted upon by a force F, and a second body has an acceleration of 15 ft./sec.^{2} when acted upon by an equal force F; if the two are combined into a single body, what acceleration will this body have if acted upon by a force F?[5]

[1] Science, December 24, 1915.

[2] Science, April 23, 1915, p. 609.

[3] Mr. Kent refers to the "good old principle, Unit force (pound) acting on unit mass (1 pound) gives it an acceleration of 32.1740 feet per second." As a matter of fact the antiquity of this "principle" is considerably less than that of the poundal (it was only in 1901 that the value 32.1740 feet per second per second was adopted by the International Conference of Weights and Measures as the most probable value of g at sea-level in latitude 45°); moreover it may be doubted whether this unit force has ever been employed practically. The really "good old" unit force is the weight of a pound mass (or kilogram mass) wherever the observer happens to be; this is still, and doubtless will continue to be, the unit employed in most practical applications.

[4] Science, March 3, 1916.

[5] The problem might be generalized as follows: A certain body has the acceleration a' when acted

The solution of such problems involves the use of a principle equivalent to the following: *The mass of a body is equal to the sum of the masses of the individual portions of matter composing it.* Professor Huntington doubtless accepts this principle (even if disapproving the language in which it is expressed); but nothing equivalent to it seems to be either expressed or implied in the eleven propositions given by him as sufficient. It is not merely that the word "mass" is not used; the term "standard weight" which replaces it is not defined or explained in such a way as to cover the above principle; there is no intimation that standard weight is the measure of an *additive property*[6] of matter—that *the standard weight of a body is the sum of the standard weights of its parts.*[7] But if this is not an

upon by the force F', and a second body has the acceleration a'' when acted upon by the force F''; a body formed by combining the two would have what acceleration when acted upon by a force F? For example, the addition of 1,000 tons to the load carried by a 5,000-ton vessel would have what effect upon the acceleration of the vessel when starting from rest with a given propeller action?

[6] Of additive properties which are invariable and possessed by *all* matter there are two: *inertia* and *gravitation*. These furnish two independent methods of making exact quantitative comparisons of different portions of matter. It is believed to be a fact that the two methods give results in exact agreement, but the basis of this belief is, and must be, precise experiment, as was explicitly recognized by Newton (although Mr. Kent apparently expects boys to learn it by watching the grocer weigh sugar). Comparing quantities of matter by weighing would involve only the property of gravitation if the earth were at rest; because of the earth's rotation it involves also the property of inertia. (The word inertia is here used in a quantitative sense for lack of a less objectionable term.)

[7] Proposition 9 includes the statement that standard weight is "characteristic of the given body," and proposition 3 the statement that "if any material is added to or taken away from the body it ceases to be the same body"; but there is no intimation that the addition of matter to a body may not produce a body of less standard weight than the original body.

essential part of the principles of dynamics as actually interpreted in solving problems, I would be glad to know how it can be dispensed with in the case of the particular problem stated above.

The point which Professor Huntington's method of statement evades is brought out clearly also by the following citations from former articles in SCIENCE:

Professor Huntington's view:[8] The statement: "Body A has three times the mass of body B" is precisely equivalent to the statement: "Body A requires three times as much force as body B to give it a specified acceleration."

Ordinary view as understood by me:[9] The statement that "body A has three times the mass of body B" means more than that "body A requires three times as much force as body B to give it a specified acceleration"; it means that the material contained in body A might be made into three bodies, each of which would require the same force as body B to give it a specified acceleration.

If the latter view is correct, it shows clearly the appropriateness of the words "quantity of matter" as a brief definition of mass.[10] If it is not correct, I would again ask how it is possible to solve problems such as the one given above.

If a proposition expressing the fact that the standard weight of a body is equal to the sum of the standard weights of its parts is added to Professor Huntington's eleven numbered statements, the scheme becomes indeed logically "sufficient" as an explanation of the fundamental equation of motion. It is also, of course, logically redundant, all that part referring to gravity being irrelevant as regards the real meaning of the laws of dynamics. This redundancy is not necessarily objectionable

[8] SCIENCE, July 30, 1915, p. 159.

[9] SCIENCE, September 10, 1915, p. 341.

[10] The significance of the words quantity of matter in dynamics was discussed in a former communication (SCIENCE, September 10, 1915). A fuller analysis is given in an article published in the *American Mathematical Monthly*, February, 1916.

in a preliminary explanation, but the fact should finally be made clear that the second law of motion is quite independent of the law of gravitation and of the facts of terrestrial gravity. The fact that the word weight is usually associated with gravity makes the term "standard weight" misleading and inappropriate as the name of a "characteristic of the given body" which has nothing to do with gravity.[11]

Full comment on the latest communications of Mr. Kent and Professor Huntington would consist largely of the repetition of comments made in previous communications by myself and others, and I shall take space only for a remark regarding their attitude toward the equation $F = ma$. They agree in objecting most strenuously to the use of this equation. The grounds of the objection as stated by Professor Huntington are that it implies "a perfectly arbitrary choice of units" and a choice that is "needlessly complicated and quite unscientific." When these objections are considered in connection with the units endorsed by both Mr. Kent and Professor Huntington, the implication seems to be that it is less arbitrary, less complicated and more scientific to define a unit force as "the force which would give the unit mass 32.1740 units of acceleration" than as "the force which would give the unit mass one unit of acceleration." What reason there is for such a supposition it is not easy to see.

The fact that the choice of units is always arbitrary is indeed a very important fact to emphasize with students, and probably the only way to do this effectively is to give practise in the use of different sets of units in solving the same problems. If any author states or implies that the unit force *must* be defined as the force which would give unit mass unit acceleration, he makes an unfortunate mistake; but the same may be said of one who states or implies that the force which would give a unit mass 32.1740 units of acceleration is other than an arbitrarily chosen unit.

L. M. Hoskins

Stanford University,
April 8, 1916

[11] This inappropriateness is strikingly apparent in referring to astronomical masses. In a recent lecture by an astronomer of high reputation the statement was made that the sun contains more than 97 per cent. of the matter in the solar system. How would this fact be expressed by Professor Huntington? Would he speak of the "standard weights" of the sun and the solar system?

ELECTRICAL ACTION AND THE GRAVITATION CONSTANT

In Science for December 31 Professor Nipher suggests that previous determinations of the gravitation constant may be in error, owing to the force action of electric charges on the attracting masses. The point is interesting, but in estimating the possible magnitude of the effect the author seems to have committed a serious error.

He puts the charge Q on a sphere equal to RV, where R is the radius and V is the *absolute* potential of the sphere. But this equation holds only when the sphere is alone in space; otherwise it may be nowhere near true. Consider, for instance, an insulated uncharged sphere inside a closed metal box. By charging up the box we may change the absolute potential of the sphere by a large amount without placing any charge whatever upon the sphere itself.

If Professor Nipher really has made this slip, he is at least in august company. For no less an authority than Boltzmann fell into a similar error, when he set the capacity of a conducting molecule *between two conducting plates* equal to its radius.[1]

In the classical experiments on the gravitation constant charges certainly existed on the attracting masses, in consequence of contact potentials between metals if for no other reason. But Professor Nipher's calculation indicates a possible error due to contact potentials of only a per cent. or two. Furthermore, the electric effect would be enormously influenced by the nature and arrangement of other parts of the apparatus, and these have varied widely. It seems doubtful, therefore, whether the actual error due to this cause can exceed the very

[1] Gastheorie, I., p. 79.

small discrepancies between the best modern determinations of the constant.

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GRAVITATION AND ELECTRICAL ACTION

IN a recent number of SCIENCE[1] Professor F. E. Nipher has pointed out that the force exerted between two isolated solid spheres depends not only upon their mutual gravitational attraction, but also upon the electrostatic charges carried upon their surfaces, and suggests that this fact has been ignored in determinations of the gravitational constant by experimenters from Cavendish to Boys. The fact that the potential of the earth relative to points infinitely remote is not necessarily zero, and the further fact that the earth's surface may at a given time and place be heavily charged owing to volume changes in the atmosphere are urged to show that the spheres employed in the experiments referred to may have carried appreciable charges.

That Professor Nipher's expression for the electrostatic force between two charged spheres is applicable only to the case in which the distance between their centers is great compared with the radius of the larger is perhaps of little importance in view of the fact that the torsional systems in all experiments on the gravitational constant have been effectively shielded from electrostatic action. The important condition is, of course, that displacements of the torsional system shall not alter the electrostatic capacity of the earth, or of the earth-atmosphere condenser, and this condition is satisfied when the system is surrounded by a conducting casing. In Boys' experiment the torsional system was enclosed in a double metal casing and the apparatus was installed in an underground vault.

It does not seem impossible that contact differences of potential between the parts of the torsional system and the casing may have affected results in some of the experiments, although in Boys' experiment the symmetry of the apparatus was such that forces arising from contact differences of potential could have exerted only inappreciable torques on the suspended system.

There would seem to be little reason for thinking that the gravitational constant is not known to within one part in 3,000, Professor Boys' estimate.

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PITTSBURGH, PA.

[1] March 31, 1916, page 472.

AMBYSTOMA NOT AMBLYSTOMA

IN view of the recent difficulty I have experienced in trying to have the generic name of the spotted salamander spelled *Ambystoma* as originally written by Tschudi, it seems desirable to call attention to the correct form of the word. In reporting the exhibition of a specimen of this salamander before the Biological Society of Washington I took pains to see that the word was correctly spelled in manuscript. The report has appeared in print twice and in each instance an *l* has been inserted by the publisher.[1]

The word was proposed by Tschudi[2] in 1839 and written by him *Ambystoma* in four different places in his work, and only in that manner. The derivation of the word is not given by him and there is nothing to indicate that he intended *Amblystoma* and made a lapsus calami. The first author to employ *Amblystoma* was Agassiz[3] in 1842–1846. This spelling has had a very wide acceptance and it is the one usually employed by morphologists, embryologists, physiologists and others who are not systematists. A discussion of the appropriateness of *Ambystoma* and its possible derivation from ἀνὰ στόμα βύειν meaning to cram into the mouth is given by Stejneger in his "Herpetology of Japan."[4] The correct form of the word is employed by Hegner[5] in his "College Zoology," but aside from this most of the non-specialist authors that I have lately seen incorrectly spell the word with the *l* inserted.

[1] *Jour. Wash. Acad. Sci.*, Vol. 6, p. 258, May 4, 1916. SCIENCE, N. S., Vol. 43, p. 761, May 26, 1916.

[2] *Mém. Soc. Sci. Nat. Neuchatel*, Vol. 2, section 4, pp. 57 and 92, 1839.

[3] Nomencl. Zool. Rept., p. 2, 1842–46.

[4] *Bull. U. S. Nat. Mus.*, No. 85, p. 24, July 22, 1907.

[5] "College Zoology," p. 511, 1912.

Dr. Stejneger has called my attention to the fact that the specific name under which Mr. Doolittle's specimen was reported should properly have been written *Ambystoma maculatum* instead of *Ambystoma punctatum*, as shown by him in 1902.[6]

M. W. Lyon, Jr.
George Washington University

CENTIGRADE VERSUS FAHRENHEIT

In the article by A. H. Sabin, appearing in the May 5 issue of Science, entitled "The Centigrade Thermometer," were expressed the sentiments of many scientific workers, who have had no other method of voicing their opposition to his scheme accorded to them by Representative Johnson, than through articles in various publications.

In the judgment of the writer the set of questions submitted to him by Mr. Johnson should have been so constituted as to have permitted the views of the opposition to have been presented.

The *inconvenience* of the Fahrenheit scale is not apparent to the writer.

The number denoting the temperature range between the freezing point (32°) and the boiling point (212°) of water, being 180 is divisible without a remainder by 1, 2, 3, 4, 5, 6, 9 and 10; while the number for the Centigrade scale denoting the same range, namely 100, is divisible by only 1, 2, 4, 5 and 10 without a remainder; or three less divisors, tending to arouse the suspicion that the Fahrenheit scale is more "rational" than the Centigrade scale.

It is the opinion of the writer that such a change as is contemplated by Mr. Johnson would not only be idiotic, but a most undesirable blow at *educational efficiency*, the most important factor entering into the life of every human individual.

F. E. Austin
Hanover, N. H.

SAFETY RAZOR BLADES FOR HAND SECTIONING

If there are still any botanists so old-fashioned as to cut sections by hand, they may be glad to know, both for themselves and for their students, of the convenience and cheapness of the razor I am now using.

The present stropping handle of the Gem Safety Razor is the holder, the Gem Damascene the blade. The total cost is about fifteen cents. The blades, when dull, can be replaced for five cents, but in the stropping holder they may very easily be kept sharp.

I find this thin, keen, easily stropped razor admirably suited to light work. I am not sure that it would be heavy enough to cut hard wood satisfactorily, but it sections leaves, stems and roots, even of considerable size and hardness. I am so pleased with the result that I wish to share it.

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California

[6] *Proc. Biol. Soc. Wash.*, Vol. 15, pp. 239–240, December 16, 1902.

SCIENTIFIC BOOKS

Ptolemy's Catalogue of Stars. A Revision of the Almagest. By C. H. F. Peters and E. B. Knobel. Carnegie Institution of Washington, 1915.

It will give pleasure to astronomers to have this long and careful work on the collation of existing manuscript copies of the "Almagest" so well presented in published form. It is the oldest known catalogue of measured star places, and while observers of this day can receive little assistance in comparing those rough measurements with modern positions, the catalogue will still exhibit the changes in the heavens due to precession, and it serves as a record of the unchanging character of the distribution of the bright stars.

No original copy of Ptolemy's "Almagest" is in existence, so far as known, and the earliest manuscripts thus far found were made eight or nine centuries after the epoch of the catalogue. Both Greek and Arabic manuscripts are among the early transcripts; the Latin copies were translations of either one of these. In the transcriptions many errors were made, due in part to the ignorance of astronomical science on the part of copyists, and to the difficulties of translating the nu-

merical terms of the original, some of which can easily be misconstrued unless the form is exactly noted. To reconcile if possible the differences in the various manuscripts, and then to identify the stars observed with the present known positions, were the objects of the revision. Any probable explanation of the source of an error makes it easier to accept a correction, and for such explanations a thorough acquaintance with the language in which the results were recorded, as well as knowledge of the character of the results are required. Both these requirements were fulfilled in a remarkable degree by Dr. Peters. Grounded in his astronomical training under the tutelage of Encke and Gauss, he possessed the painstaking and thorough habits of the mathematical investigator, joined to a wide culture from his varied life in different European countries. His residence of several years at Constantinople gave him a fluent knowledge of Turkish, Persian and Arabic, besides his training in Greek, Latin and Hebrew, and his acquaintance with the usual European languages, which the old time culture demanded of an educated man. Following his revolutionary experiences, he came to this country in 1854, and soon after was associated with Dr. B. A. Gould, in the Dudley Observatory at Albany, which he left to become professor of astronomy at Hamilton College. In the period of over thirty years of his directorship of the observatory at Clinton, he made several trips abroad, and searched the capitals of Europe for the manuscripts of the "Almagest," sparing neither time nor labor in studying every detail relating to the star positions on record. The "Almagest" contained a full summary of all existing knowledge of the apparent movements of the sun, moon and planets, the division of practical astronomy to which the attention of the earliest students of the sky would be most naturally attracted. The seventh and eighth books were devoted to the catalogue of northern and southern stars, respectively. Ptolemy did not accept any other explanation of the universe than that of a central earth, without rotation, though ideas more in conformity with the actual form of the solar system had even at that time been more than once subjects of speculation. The value of the obliquity of the ecliptic was known, and the effect of the precession could be closely calculated. His positions were given in longitude and latitude, for an epoch known to be about A.D. 138. But the earliest comparisons of his positions showed that they were approximately true for a much earlier period, following the epoch of the observations of Hipparchus by about one hundred and ninety years, thus corresponding nearly to the epoch A.D. 60. The present publication, while presenting much of the evidence from all points, adds nothing to the solution of the question whether the places of Ptolemy's catalogue were derived from any observations of his own, or were simply the observations of Hipparchus, brought up to the later epoch by the addition of a constant correction to the longitudes, for the effect of precession.

After Dr. Peters had begun his study of the foreign manuscripts, Mr. E. B. Knobel, at one time president of the Royal Astronomical Society, learned that they were both engaged upon the same search; and as Dr. Peters did not plan to work in the English museums and libraries, they entered into hearty and unselfish plans of collaboration, to include all available sources of authority.

The description of their mutual labors has been written by the English astronomer, and the results have been tabulated by him, after much extra discussion and transcription of the original notes of Dr. Peters. In all, thirty-two copies of the "Almagest," now preserved in Rome, Paris, Vienna, Venice, Oxford and London, were examined by the two investigators, and the places of the stars from twenty-six of these manuscripts have been tabulated for comparison. The magnitudes from seven manuscripts have also been tabulated. The stars have been given Baily's numbers, consecutively, to No. 1,028, through the various constellations in which the catalogue of Ptolemy was collected. The places and

magnitudes are always those derived by Dr. Peters; and the identification with modern star designation, a tabulation of the errors found, and the comparison with the Harvard photometric magnitudes have been added. The fact that Ptolemy lived at Alexandria, four degrees south of Rhodes, the site of Hipparchus's observations, and yet did not include any more southern stars than did the latter, is one point of evidence against a new series of observations by Ptolemy. Hipparchus is supposed to have observed 1,080 stars. The work of identification involved the reduction of modern star places back to the respective epochs of the old observations, and, with this, the computation of the probable errors of the old measures. These had been recorded in fractions of a degree, and the fact that much confusion arose in transcribing these fractions in the Greek has added to the uncertainty of some of the identifications. Many of the manuscripts in existence are evidently copied from some particular original, and the errors of that original would be reproduced, in addition to new mistakes of transcription.

After the death of Dr. Peters, in 1890, the collection of material made by him was sent to Mr. Knobel, who has enlisted the support of astronomers and public-spirited men in having the results of their joint labors properly recognized by the publication in permanent form. The volume contains an excellent portrait of Dr. Peters, and some photographic reproductions of the pages of the two oldest copies of the "Almagest."

R. H. Tucker

Lick Observatory,
March 21, 1916

Flora of the Northwest Coast. By Charles V. Piper and R. Kent Beattie. Published by the authors, Washington, D. C., November 10, 1915. Pp. xiii + 418. Price $1.50.

Students of the flora of western North America will welcome Piper and Beattie's "Flora of the Northwest Coast." The authors are to be congratulated for bringing to fruition the labors of their earlier years for the botany and botanical education on the Pacific coast. Their new work will contribute greatly to the knowledge of the plant life in the northwest and, as they themselves express the hope, will "stimulate a greater activity and interest in the flora."

The area covered by the manual is that lying west of the summit of the Cascade Mountains from the headwaters of the Willamette River in southern Oregon to the 49th parallel of latitude. This is a natural geographic region characterized by its magnificent coniferous forests which form the dominating plant formations over nearly the entire area below 5,000 feet altitude. "The only break in this coniferous cover consisted originally of a series of prairies extending from the Upper Willamette Valley northward to Vancouver Island. North of the head of Puget Sound, however, the prairies are small and limited in the main to the extremities of points and portions of the islands in the Sound."

In a forested region such as the northwest the lignescent flora naturally attracts attention, and it is interesting to note that, although the forests are largely composed of a few species of conifers, there is a comparatively large variety of trees and shrubs, approximately 9½ per cent. of the total flora. Of the 155 species of woody plants described, 47 are trees, 105 shrubs and 3 woody climbers. The genera with more than two species of trees are, *Pinus* 6, *Abies* 6, *Salix* 5, and *Acer* 3. The genera with five or more species of shrubs are, *Salix* 14, *Ribes* 10, *Spiræa* 5, *Rubus* 6, *Ceanothus* 6, and *Vaccinium* 9.

A summary of the flora is given in a table, from which we learn that there are described, 100 families, 550 genera and 1,617 species and subspecies, distributed as follows: Pteridophyta 7 families, 22 genera and 61 species; Gymnosperms 2 families, 10 genera and 22 species; Monocotyledons 15 families, 111 genera and 412 species; Dicotyledons 76 families, 407 genera and 1,122 species. The composition of the flora may be brought out a little more fully by listing a few of the prominent families and genera. The families containing more than 60 species are: Poaceæ 46 genera and 116 species,

Cyperaceæ 7 genera and 95 species, Cruciferæ 28 genera and 69 species, Rosaceæ 28 genera and 61 species, Leguminosæ 13 genera and 72 species, Compositæ 66 genera and 89 species. The genera containing more than 15 species are: *Agrostis* 18, *Poa* 22, *Carex* 73, *Juncus* 23, *Salix* 19, *Polygonum* 20, *Ranunculus* 19, *Lupinus* 19, *Trifolium* 20, *Epilobium* 18, *Erigeron* 17 and *Senecio* 17. All of these genera with the exception of *Trifolium* and *Lupinus* are common not only throughout the cooler parts of North America, but of Europe and Asia as well. In fact, while there are many endemic species, the general floral element is that of the Boreal Realm, just as we would expect, since the region lies within the Arctic to Transition zones. Very few of the typical American genera of the arid regions of the west are represented.

The text is supplied with keys to families, genera and species, but the descriptions of the species are often meager, too much so we fear in some cases for certain identification. But in the reviewer's mind the most disappointing feature of this admirable work is the extremely meager and indefinite distributional notes. It is to be regretted in this respect that the authors did not follow the excellent example set by the senior author in his "Flora of Washington," and give the zonal distribution. Two additional words would have been sufficient, and these with a little fuller definition of each zone in the preface would have been of great service to the student of plant distribution.

LEROY ABRAMS

NOTES ON METEOROLOGY AND CLIMATOLOGY

FROST

PROFESSOR ALEXANDER MCADIE and Mr. William G. Reed have each recently presented several papers on the meteorology of local frosts, the causes of frost damage to plants and methods of protection, the dates of occurrence of frost, and bibliography of frost in the United States.

The meteorology of frost formation is discussed by Professor McAdie in an article entitled "Temperature Inversions in Relation to Frosts."[1] Two laws of frost formation are enunciated as follows:

> (1) Where the air is in motion, there is less likelihood of frost than where the air is stagnant; (2) frost is more likely to occur when the air is dry (and dustless) than when it is moist.

The first is true because local frosts are connected essentially with local "air drainage." Soon after sunset, cold and dense air, cooled chiefly by radiation to the ground, drains slowly down the slopes into the valleys and low places. Strong winds mix the air and so prevent the occurrence of local frosts. The second law is based on the retardation of temperature change due to moisture in the air. The water vapor strongly absorbs the heat rays from the earth, acting in this way as a blanket. If condensation occurs, there is further retardation of the cooling by the liberation of latent heat. Since dry air is denser than moist air at the same temperature, a loss or gain of moisture as well as a change in temperature affects the rate of "air drainage." To obtain a continuous record of the weight of water vapor in grams per cubic meter of air, Professor McAdie has devised a "saturation deficit recorder." This instrument is essentially a hygrograph mounted on the pen of a thermograph. The thermograph indicates the maximum weight of water vapor possible in the air at the temperature prevailing, and the hygrograph indicates the percentage of saturation.

Protection of plants from injury by frost involves the conservation of the earth's heat with covers, the addition of heat to the air, or the use of some agency with high specific heat, such as water, to prevent cooling. Preventable damage often results from too rapid defrosting in the morning; fortunately, the same agents which keep the temperature from falling retard its rise.

Mr. Reed treats the subject of protection as a whole in an illustrated article, "Protection from Damage by Frost."[2] The methods most successful commercially depend upon the com-

[1] *Annals*, Harvard College Observatory, Vol. 73, pp. 168 to 177, 4 pl., Cambridge, 1915; or see *Scientific Monthly*, December, 1915, pp. 293 to 301.

[2] *Geographical Review*, February, 1916, pp. 110 to 122.

bination of heat and smoke; in the best orchard practise there is a fairly clean-burning small fire to each one or two trees. Economical and effective use of heaters involves the information and warnings issued by the U. S. Weather Bureau, and knowledge of the local seasons of frost and places of lowest temperature. The methods of protection should be studied, and the type which has proved successful in the particular region or in one where the conditions are similar should be selected. The campaign should be carefully planned in advance. Protection is so expensive that crops of high value only can carry the charge.

Protection is but one aspect of the frost problem. The problem for the farmer is to determine the frost conditions he will have to meet and to arrange his crops and his agricultural practise to suit these conditions. Apparently, the first frost maps of the United States were made by Mr. P. C. Day.[3] Maps are presented showing average and extreme dates of the last killing frost in spring, and of the first in autumn, and the average length of the growing season. Isochronal lines are shown east of the Rocky Mountains, and figures are given at stations west of the mountains. Later, more extensive frost data, included in the original records of the cooperative observers of the Weather Bureau, were edited, and tabulated; and new frost maps of the United States have been constructed on a scale of 1/2,500,000, the records used being within the period 1895 to 1914. In this work the Office of Farm Management and the Weather Bureau cooperated. A preliminary study of these maps was presented by Mr. Reed at the Second Pan-American Scientific Congress. Parts of the author's abstract are quoted here:

> Killing frost . . . is a temperature low enough to destroy plant tissue. Frost is measured by the effect on plants, but it would be better to use some definite temperature.
>
> Most of the United States is subject to annual killing frosts. Low temperatures are most dangerous to plants at the beginning and end of the growing season. Frost is an anticyclonic phenomenon. East of the Rocky Mountains it is frequently possible to follow a frost across the country; west of the Rocky Mountains frost occurs when an anticyclone overlies the region.
>
> Records of frost occurrence are now available for over 5,000 places. These may be supplemented by knowledge of topography and vegetation, and although the term is of doubtful meaning, "average dates" of killing frost may be determined. Frost risks may be determined by the use of the "standard deviation." Maps of the average date of last killing frost in spring, and the frost killing in autumn, and of the length of the season without killing frost have been drawn. Between one quarter and one third of the country is subject to frost after June 1 and before September 1. Computed dates of last spring frost and first autumn frosts in nine years in ten, as well as the length of the season without killing frosts in four years in five, have been mapped.
>
> Mountain masses are more subject to frost than lower regions, but the relations are complicated by "air drainage," which makes frost more common in valleys than on slopes. . . .

Mr. Reed and Miss Cora L. Feldkamp have published a "Selected Bibliography of Frost in the United States."[4] It is arranged with the later papers first, as most of the work is very recent; earlier papers cover substantially the same ground. Thus 26 of the 94 articles are dated 1914 or 1915. An index by states is added. Although the titles are few in number, they were selected from all the material on "frost and frost prevention under American conditions," found in the libraries of Washington, the published bibliographies of the John Crear Library (Chicago), and references in many agricultural and meteorological magazines and other publications.

WEATHER AND THE WAR

There are two aspects of the relationships between weather and the war: weather has a decided control on military operations; but it is a question whether the war has any effect on the weather. Professor R. DeC. Ward has undertaken a thorough study of the former, and has published some of the results in the

[3] Weather Bureau Bulletin V., 1911, 5 pp., 5 maps.

[4] *Monthly Weather Review*, October, 1915, pp. 512 to 517.

Popular Science Monthly[5] and in the *Journal of Geography*.[6] The decrease in military activity at the opening of winter indicates the deterrent effect of winter weather on military operations. As the speed of movements in the field is dependent primarily on the condition of the ground, cold weather in winter is almost invariably accompanied by greater military activity. Since the Russian theater has colder and drier weather in winter than that in the west, operations there are less hindered by mud. On the other hand, in autumn the flooding rains present great difficulties in the east. The prospect of the usual autumnal rains and the intrenchment difficulties of the winter probably spurred the Germans and Austrians to their remarkable activity in the summer of 1915 even in spite of heavy mud.

At great altitudes, meteorological hindrances are much more acutely felt. High mountains mean cold and snow even in summer. Also mountains have more clouds, more rain and more thunderstorms than the lowlands. In winter, fighting is extremely difficult. Operations in the Alps, Carpathians, Balkans and Caucasus have almost always been mentioned in the same breath with the unfavorable weather conditions.

Furthermore, too great dryness makes operations difficult anywhere. Thus on Gallipoli peninsula and in Mesopotamia there was a scarcity of water, and the dust was almost unbearable in the summer dry season. The difficulties of operations in deserts are such as to make Egypt fairly safe from attack. The story of the operations in Mexico is not without mention of the winds, dust, sand and heat of the desert.

For air and naval engagements, foggy conditions are generally chosen. This has been shown abundantly in the Zeppelin raids on England, the aeroplane raids of the French in Germany, and in the infrequent naval attacks on coasts. For the use of asphyxiating gases, wind conditions must be just right: steady, moderate, and from the proper quarter.

On the effects of battles on rainfall, the excessive raininess of the winter of 1914 to 1915 in the British Isles and weather anomalies elsewhere have occasioned some comment. Charles Harding presented before the Royal Meteorological Society[7] a summary of the weather conditions for eight stations in Great Britain and eight continental ones for the period August, 1914, to April, 1915. In connection with the discussion as to the cause of the extraordinarily heavy rainfall which was experienced in England, Dr. H. R. Mill, director of the British Rainfall Organization, made the following statement:

> The vastness of the work done by the quiet processes of nature requires only to be realized in order to show the incalculable improbability of gunfire in France producing a wet winter in England. Take the case of the three and a half inches of rain which fell in excess of the average in December over 58,000 square miles of England and Wales. This quantity is 203,000 square mile inches or 13,126,920,000 tons. At winter temperatures, saturated water vapor would form about 1 per cent. of the mass of the atmosphere containing it, hence the minimum quantity of air which must have been carried over England and Wales in December, 1914, must have exceeded 1,300,000,000,000 tons. The amount of force required even to deviate the direction of moving masses of this magnitude is surely far beyond that which can be exerted even by nations at war.

Professor Cleveland Abbe in the *Popular Science Monthly*, January, 1911, shows by laboratory experiments that the firing of cannon or dynamite to produce rain can not possibly succeed. *The Scientific American*, October 24, 1914, contains an instructive article on the subject; and Professor McAdie in the *Scientific Monthly*, February, 1916, gives a brief summary of the question.

HEAVY SNOWFALL IN NEW ENGLAND

DURING the past winter the snowfall in parts of New England exceeded all previous records (since 1873) for any winter. The

[5] December, 1914, pp. 604 to 613.

[6] February, 1915, pp. 169 to 171; March, 1915, pp. 209 to 216; November, 1915, pp. 71 to 76; June, 1916, pp. 374 to 384.

[7] *Quarterly Journal*, October, 1915, pp. 337 to 348.

snowfall of the early winter was greater in the western than in the eastern part of New England, but not later, owing to the cooling of the ocean water.[8]

SNOWFALL, 1915 TO 1916 (INCHES)

	November	December	January	February	March	April	Total	Av. 1895 to 1913
Eastport, Me.....	T	4.4	14.2	21.8	15.7	6.5	62.6	87.2
Portland, Me.....	T	12.0	12.2	20.2	36.3	7.9	88.6	73.1
Boston, Mass.....	0.2	6.7	4.8	30.3	33.0	4.2	79.2	41.1
Blue Hill, Mass.[9]	1.0	12.3	6.4	33.4	42.2	16.2	111.5	58.2
Worcester, Mass.[9]	T	15.8	6.2	24.9	36.0	5.6	88.5	50.9
Albany, N. Y.....	0.1	40.3	0.6	13.7	37.9	2.1	94.7	46.0
Providence, R. I...	0.3	3.5	0.8	15.1	19.1	4.7	43.5	42.1
New Haven, Ct. ..	T	18.0	1.6	24.7	29.0	2.7	76.0	37.8

In New Haven the ground was snow-covered from February 3 to March 28, 1916. Two features prevented the occurrence of floods when the snow melted. First, on account of the lateness of the melting, the ground was thawed out below and so received readily the water from the melting snow. Second, the melting took place in clear, cool weather and lasted over a period of four days.[10]

The season ended with a fall of snow in eastern New England on April 28, amounting to eight inches at Blue Hill.

PROFESSOR CLEVELAND ABBE

At the annual meeting of the National Academy of Sciences held in Washington in April, 1916, Professor Cleveland Abbe was awarded its gold medal for "eminence in the application of science to the public welfare, in consideration of his distinguished service in inaugurating systematic meteorological observations in the United States." Unfortunately, on account of illness Professor Abbe could not be present to receive the medal in person. Since last June he has been incapacitated by partial paralysis for his work as editor of the *Monthly Weather Review*.

Professor Abbe, who is in his seventy-eighth year, has had forty-four years of distinguished service in government meteorology, a period significantly equal to the length of record of most regular Weather Bureau stations. Early in his career, Professor Abbe was an astronomer. On September 1, 1869, while he was director of the Cincinnati Observatory, he inaugurated daily weather reports for the Cincinnati Chamber of Commerce, which at once led the United States government to take up similar work. From 1871 to 1891 he was professor of meteorology and civilian assistant in the office of the chief signal officer, U. S. Army; and with the change of the weather service to a civil bureau in 1891 he continued as professor of meteorology in the Weather Bureau. As editor of the *Monthly Weather Review* from the time of its foundation to the present[11] Professor Abbe has been in touch with, and stimulated great numbers of meteorological observers and investigators. Although he was in a position to carry on but few original investigations, he did an immense amount of translation and compilation of the results of others' meteorological investigations. Among the more important of his works are: "Meteorological Apparatus and Methods" (1887); "The Mechanics of the Earth's Atmosphere" (1891 and 1909); and "First Report on the Relations between Climates and Crops" (1905, as of 1891).

To him belongs the credit of publishing a "Report on Standard Time" (1879) which started the agitation that resulted in the modern standard hour meridians from Greenwich.

Professor Abbe is a member of a great many domestic and foreign scientific societies, among them being five meteorological societies of Europe. Two signal honors from his con-

[8] See Science, February 11, 1916, p. 212.

[9] Sleet included; since January 1, 1909, regular Weather Bureau Stations have measured sleet separately. Thus, if sleet were included, the total for New Haven would be 82.3 instead of 76 inches.

[10] See article on snow-melting, by A. J. Henry, *Monthly Weather Review*, March, 1916, pp. 150 to 153.

[11] In the period 1909 to 1913, inclusive, the *Monthly Weather Review* was divided into two sections, the one which kept the title including the observational material, and the *Bulletin of the Mount Weather Observatory*, the discussional. Professor Abbe edited the latter only.

temporaries abroad are the degree of LL.D. from the University of Glasgow in 1896, and the Symons Gold Medal of the Royal Meteorological Society in 1912.

CHARLES F. BROOKS
YALE UNIVERSITY

SPECIAL ARTICLES

A NEW FORM OF PHOSPHOROSCOPE[1]

EXISTING phosphoroscopes are of two types, those with a periodically interrupted source of light and those employing a steady source.

To the first type belongs the classical instrument of E. Becquerel,[2] subsequently modified by E. Wiedemann,[3] in which the object is placed between two parallel revolving disks and is alternately illuminated and observed through properly placed and adjustable openings.

In 1908 Merritt,[4] devised a phosphoroscope in which the phosphorescent surface *P*, Fig. 1, was illuminated periodically by the passage

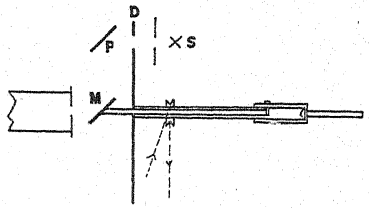

FIG. 1.

of an opening in a revolving disk *D* mounted between it and a source of light *S*. The phosphorescence was observed at the desired time after exposure by means of a small revolving mirror, *M*, mounted obliquely on the end of the shaft. The disk was carried upon a hollow sleeve revolving with the shaft and the angle between the opening in the disk and the plane of reflection of the mirror could be varied during rotation.

With this apparatus curves of decay of numerous cases of phosphorescence of short duration were determined by Messrs. Waggoner[5] and Zeller.[6]

In these phosphoroscopes, the source of light is not in itself necessarily intermittent, the periodic interruption of excitation being produced by the use of a revolving sectored disk. Another group of instruments of this general type employs the intermittent discharge from an induction coil or transformer, as in the spark-phosphoroscope briefly described by Laborde in 1869,[7] Crookes's device with sectored disk and commutator for observing the afterglow of substances subjected to kathode discharge,[8] Lenard's[9] phosphoroscope of 1892 and de Watteville's[10] apparatus for the spectroscopic study of phosphorescence (1906). Lenard's instrument differs from the others of this group in that the eclipse of the exciting spark is produced by the linear movement of a screen mounted upon the plunger of a Ruhmkorff mercury interrupter in the primary circuit of the induction coil.

The other type of phosphoroscope, in which an uninterrupted source of light is used, likewise had its origin with Becquerel.[11] It was later used for lecture demonstrations at the Royal Institution by Tyndall[12] and for measurements by Kester,[13] Waggoner[14] and others. It consists simply of a cylinder revolving on a

[1] A paper presented at the April meeting of the American Physical Society, 1916.

[2] E. Becquerel, *Annales de Chimie et de Physique* (3), 55, p. 5, 1859.

[3] E. Wiedemann, *Wiedemann's Annalen*, 34, p. 446 (1888).

[4] Nichols and Merritt, "Studies in Luminescence," Carnegie Institute of Washington, Publication No. 152.

[5] C. W. Waggoner, *Physical Review* (1), XXVII., p. 209.

[6] Carl Zeller, *Physical Review* (1), XXX., p. 367.

[7] Laborde, *Comptes Rendus*, 68, p. 1,576.

[8] Crookes, *Proc. of the Royal Society*, 42, p. 111 (1887).

[9] Lenard, *Wiedemann's Annalen*, 46, p. 637.

[10] C. de Watteville, *Comptes Rendus*, 142, p. 1,078.

[11] E. Becquerel, *Ann. de Chimie et de Physique* (3), 62, p. 5 (1861).

[12] See Lewis Wright, "Light," London, 1882, p. 152.

[13] Kester, *Physical Review* (1), IX., p. 164.

[14] Waggoner, Publications of the Carnegie Institution of Washington, No. 152, p. 120.

vertical axis, *A*, Fig. 2, and carrying a layer

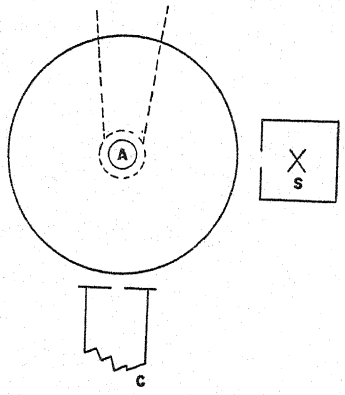

Fig. 2.

of the phosphorescent substance on its periphery.

A source of light, *S*, illuminates the traveling surface through a fixed vertical slit and the various stages of the phosphorescent glow may be studied by observing at different angles from this opening. In the form used by Waggoner, where a wheel of 45 cm. diameter was used instead of the small drum of Tyndall and of Kester this instrument has many advantages over other forms provided the substance is available in sufficient quantity to coat the entire rim of the wheel. With a speed suit-

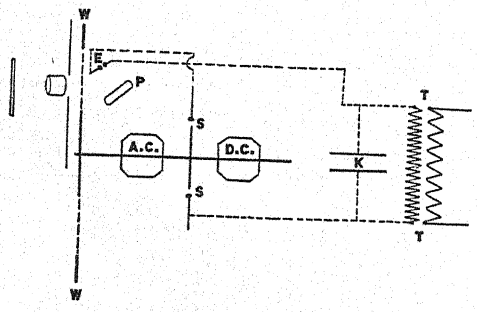

Fig. 3.

able to the substance under observation the whole phenomenon of the decay of phosphorescence may be viewed at a glance, including progressive changes of intensity and color.

The instrument, which we have called the *synchronophosphoroscope* and which is to be described in the present note, was devised for various studies in phosphorescence to which the previous types are not easily adaptable. It consists of a small synchronous, alternating-current motor A. C., Fig. 3, and a small direct-current motor D. C. upon a common shaft. To one end of the shaft is attached a sectored disk, *WW*, Figs. 3 and 4, with four equal open and four closed sectors, corresponding to the four poles of the A. C. motor. On a circuit of 60 cycles this machine, when brought to speed by the D. C. motor and released, runs steadily at 30 revolutions per second. A "step up" transformer *TT*, in the same alternating current circuit produces discharges at the spark gap, or series of gaps (*E*), at each alternation, *i. e.*, 120 times a second. This discharge may be reduced to a single spark by proper adjustment of the resistance and capacity of the circuit or more conveniently for many purposes the discharge may be confined to the peak of the wave by means of the four-pointed star-wheel, *SS* (Figs. 3 and 4), which is mounted

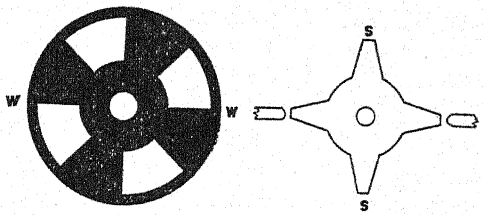

Fig. 4.

on the shaft and carefully adjusted as to phase.

The direct-current motor may also be used to drive the sectored disk at other speeds, in which case the circuit of the motor A. C. is broken and the discharge is derived from any convenient source capable of producing a proper spark at each quarter revolution.

When the sectored disk *WW* is so adjusted on the shaft that the closed sectors conceal the phosphorescent surface during excitation by the spark, an observer, looking through the open sectors as they pass, sees the phosphorescence as it appears a few ten thousandths of a second after. The apparatus is thus suitable for the study of phosphorescence of very short duration or of the earliest stages in cases of slow decay. By shifting the sector on the

shaft it is possible without variation in the rate of rotation to make observations at the very beginnings of phosphorescence and to compare by simultaneous vision, the appearances, just before and immediately after the close of excitation, or on the other hand the earlier with the later stages, up to about .004 second. The photometer, spectroscope, spectrophotometer, camera, etc., may all readily be used with this form of phosphoroscope and studies of the most varied character become possible.

The instrument has already been employed in various determinations, some of the results of which have been reported elsewhere.

To study the change of color during the decay of phosphorescence in the case of certain sulphides, color photographs[15] by the Lumière process were taken, first of the glowing surface as it appeared through the sectored disk at full speed and then for comparison with the disk revolving very slowly.

To determine the effect of temperature the tube containing the sulphide was mounted within a cylindrical dewar bulb, and the lower end cooled to the temperature of liquid air. By keeping the upper end of the tube at $+20°$ C. a sharp temperature gradient along the axis of the tube was maintained and the very striking changes of color when the substance, under these circumstances, was excited to phosphorescence were photographically recorded.

Spectroscopic comparisons of the spectrum of the light emitted by the uranyl salts during fluorescence and at various stages during phosphorescence have been made with this phosphoroscope[16] and it has been found especially well adapted to the determination of the decay of phosphorescence in cases where, as in that of the uranyl salts, the entire process occupies only a few thousandths of a second.

EDWARD L. NICHOLS,
H. L. HOWES

PHYSICAL LABORATORY OF
CORNELL UNIVERSITY,
May, 1916

[15] Paper read at the April meeting of the American Philosophical Society, 1916.

[16] Nichols, *Proc. Nat. Acad. of Sciences*, 1916.

SCIENTIFIC QUEEN REARING

HAVING been engaged for several years in practical breeding of thoroughbred queens for commercial use, and realizing the certainty and definiteness of results if "Mendel's laws of heredity could be applied to bee breeding, I undertook to determine, if possible, the manner in which some of the most valuable traits of the different races of bees were transmitted through heredity, with the idea of combining in one strain of bees those qualities of recognized desirability, such as hardiness, prolificness, longevity, length of tongue and wing expanse. Color also was brought under observation as a means by which segregation could be more readily seen if it occurred in the second filial generation, as observed by Mendel in coat color of peas when a green-seeded variety was crossed on a yellow-seeded sort, in his experiments with the garden pea.

I was therefore much interested to see that Professor Newell, of College Station, Texas, was working along the same lines.[1] The conclusions at which he arrives, in some instances, do not accord with the facts brought out in a series of breeding tests that were conducted to determine certain (the same) characteristics.

Dzierzon was the first, I believe, to point out that drones were of the same zygotic constitution as the mother alone, and were produced parthenogenetically, the correctness of which is supported by some very convincing evidence, obtained by other reliable experimenters in the same field. Professor Newell says:

> Pure Italian queens mated to Carniolan drones produce only Italian drones, and Carniolan queens mated to Italian drones produce only Carniolan drones. This is strictly in accordance with the theory of Dzierzon, the daughters of Italian queens which have mated to Carniolan drones produce both Italian and Carniolan drones, produce them in equal numbers, and do not produce any other kind. (?) This is in accordance with the theoretical expectation under Mendelian law. (?)

[1] See "Inheritance in the Honey Bee," SCIENCE, N. S., No. 1049, pages 218–219, February 5, 1915.

If the constitution of a pure Italian queen be represented by II and of a pure Carniolan queen by CC, the former will produce gametes I and I, and the latter, gametes C and C, these being Italian and Carniolan drones respectively. (?)

These conclusions of Professor Newell are not verified in so far as I have been able to judge from the results obtained by breeding tests that I have made in various ways with drones reared from heterozygous queens. The Gulf Coast prairies near Houston, Texas, are ideal for the complete isolation of mating stations. With little difficulty locations can be found where there are no trees or shrubs of sufficient size to harbor a swarm, within a radius of from five to seven miles, which allow matings to be made with a reasonable degree of certainty.

To determine the behavior of the color factor in transmission, a pure strain of golden Italians and gray Caucasians (bred from queens that I imported) were chosen with which to make the primary or initial cross, the former giving workers of the brightest yellow color, while the workers of the latter are distinctly gray without a trace of yellow on the abdominal segments.

The result of mating a golden queen to a Caucasian drone is shown by the following scheme.

Golden queen — Zygotes — Caucasian drone

gametes: FIc, FIc × fCi, fCi

FfIiCc FfIiCc FfIiCc FfIiCc = F_1

all heterozygous females, colored like ordinary Italian workers, showing that yellow is dominant to gray, a result agreeing entirely with Professor Newell's observations of the F_1 Italian-Carniolan Cross. The gray (dark) or recessive color does not appear in this generation of workers, the reciprocal cross gives the same results.

When queens are reared from these F_1 larvæ they produce drones of the constitution IiCc the same as the mother, a fact verified by subsequent breeding tests. The following scheme shows the result of mating a heterozygous queen to a heterozygous drone.

heterozygous queen FFIiCc × ffIiCc heterozygous drone

Zygotes

gametes: FiC, FIc = fIc, fiC

FfIICc FfIiCc FfIiCc FfiiCC = F_2

females, as will be observed, segregation occurs in this generation in a true 1:2:1 Mendelian ratio, or one pure dominant, two heterozygous dominants and one pure recessive, a result similar to that observed by Mendel in the F_2 of his cross of a tall pea on a short or dwarf variety, in which he got one TT, two Tt, Tt and one tt, or (dwarf) recessive; so it is in the case of the F_2 workers, in appearance there are three that show the dominant or yellow color of the Italians and one in four is recessive, or gray in color. This feature is markedly noticeable when queens are reared from larvæ of this generation; of the number hatched, about 25 per cent. show the pure golden color, 50 per cent. appear as ordinary Italian queens, with about the same variation in general color (that these are heterozygous in constitution is proved when bred to recessive drones) and 25 per cent. of them show only the recessive color, and in subsequent breeding prove to be pure recessives and continue to breed true when mated to recessive drones. The differences in the color of the workers of this F_2 are not so accentuated as in the queen reared from the same larvæ. As shown the pure dominant queens are golden, the impure dominants intermediate in color, while the recessives are gray without any trace of yellow on the abdominal segments.

Since drones are produced parthenogenetically, we must consider the fact that the egg of the queen at maturation, when not fertilized, is reduced from the 2N (or NN) condition to the 2N — 1 (or 2N — 2) condition, showing that a whole set, N, of chromosomes is not eliminated in maturation, but only one or two chromosomes. Hence the male condition here is 2N — 1 or — 2. The condition of the gametes formed, however, is N in both sexes. Since in fertilization only 2N zygotes are produced, they are (in the case of bees) invariably females.

Therefore in parthenogenetic reproduction it seems that the chromosomes FF, or factors for femaleness, are eliminated at parturition, and the resulting zygote is a male. And so far, as observed by the tests of breeding (regardless of color) the F_1 females (queens) produce drones of the constitution ffIiCc, and are heterozygous for the factors I and C with the allelomorphs i and c, whether in queen or drone, and the only gametes that can be formed from these are IC Ic iC ic, when such individuals are bred together, heterozygous workers, as well as both *pure* dominants and *pure* recessives are produced, making it possible to recover the pure line of either race used in making the initial or primary cross.

CHARLES W. QUINN
HOUSTON HEIGHTS, TEXAS

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 555th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 22, 1916, and called to order by President Hay at 8 P.M., with 24 persons present.

On recommendation of the council George H. Clements, Washington, D. C., was elected to membership.

On recommendation of the council the following resolutions were read:

WHEREAS: Professor Wells W. Cooke, distinguished ornithologist, authority on bird migration, treasurer of the Biological Society of Washington, and an active member of the council of the society, has passed from this life, therefore be it

Resolved: That the Biological Society of Washington deeply regrets the death of one for many years so keenly interested in the affairs of the society, one who was a peculiarly efficient officer, a wise counselor and a charming companion, and extends its warmest sympathy to the family of Professor Cooke.

Signed N. HOLLISTER,
J. W. GIDLEY,
ALEX. WETMORE

Under the heading Brief Notes, Dr. Howard E. Ames commented upon a question raised at the 553d meeting as to the existence of a South American mammal having the mammæ on the dorsal surface of the body. He had ascertained that this condition existed in the coypu (*Myocastor coypu*). Dr. Ames also offered information in regard to another question propounded at the same meeting as to the ability of camels to swim: According to Dr. E. A. Mearns dromedaries used in Abyssinia were able to swim; and in a book by an English army officer of experience Dr. Ames had found a statement to the effect that camels were powerful swimmers. Comments followed by the chair and by Dr. L. O. Howard.

Under the same heading Dr. F. H. Blodgett, plant pathologist at the A. and M. College of Texas discussed the embryology of the duck weed, *Lemna* and exhibited seeds, remarking that though the plant was common the seeds were found seldom. Dr. Caldwell, of Chicago, had worked out the development of *Lemna* to the point of fertilization. Studies made by Dr. Blodgett carried the embryology from this point. The talk was illustrated by diagrams. Discussion followed by Mr. W. L. McAtee.

The first paper of the regular program was by T. H. Kearney: "Native Plants as Indicators of the Agricultural Value of Land." Mr. Kearney outlined the results of field work carried on with Dr. Shantz in the semiarid regions of the United States west of the 98th meridian of longitude. Typical areas were surveyed in Colorado, the Great Basin and in the southwest desert region. Detailed surveys defined the dominant types of vegetation and their distribution, and these were correlated with the varying degrees of salinity, moisture content and other physical properties of the soil. Areas actually under cultivation gave a check as regards productivity. From these studies it is now possible to predict agricultural possibilities by examination of the original types of vegetation in these regions. Typical plant growths and diagrams showing distribution were illustrated by lantern slides.

Mr. Kearney's paper was discussed by Messrs. W. L. McAtee, Wm. Palmer, A. Wetmore and Dr. L. O. Howard.

The last paper of the regular program was by Dr. R. W. Shufeldt: "Comparative Study of Certain Cranial Sutures in the Primates." Dr. Shufeldt stated that no other single vertebrate structure had so much written about it or was receiving more attention at the present time than the skull in man and the primates in general. This study was begun over two thousand years ago and certain names of bones bestowed by Galen in the second century are still retained. In a series of 6,000 human and about 1,000 ape skulls in the collections of the U. S. National Museum Dr. Shufeldt found that while the bones of the face exhibited but little variation, in the bones on the lateral aspect of the cranium were remarkable variations,

ALLAHABAD.

many of which are not referred to in modern works on anatomy. Frontal, parietal, temporal, alisphenoid and malar articulations show many variations in sutural lines. These again are varied by the presence or absence of epactal or epipteric bones. By means of lantern slides and diagrams these were illustrated and compared and the speaker touched upon their value in taxonomy and racial distinction and their pathological significance. Discussion followed by Drs. L. O. Howard and H. E. Ames and Mr. Wm. Palmer.

Alexander Wetmore,
Recording Secretary, pro tem.

The 556th regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, May 6, 1916, called to order by President Hay at 8 P.M., with 45 persons present.

On recommendation of the council Victor J. Evans, Washington, D. C., was elected to active membership.

The president announced the recent deaths of Charles A. Davis and S. M. Gronberger, members of the society.

The first communication of the regular program was by M. W. Lyon, Jr., "Longevity of Bacteria." Dr. Lyon described a culture of *Bacillus paratyphosus B* which had been hermetically sealed in a glass tube in ordinary culture medium for the past ten years and exhibited a living subculture which had been made from it. He called attention to the short life of certain organisms and the long life of others, especially those producing spores. This communication was discussed by Dr. L. O. Howard and Mrs. E. M. Enlows.

The second paper of the regular program was by Dr. L. Stejneger: "The Amphisbænoid Lizards and their Geographic Distribution." Dr. Stejneger called attention to the various theories that have been advanced to account for distribution of animals and explained how the Amphisbænoid lizards with their peculiar morphology and habits were particularly adapted to show former connections with now separated land masses and islands. The distribution and relationships of these lizards clearly showed a former land connection between South America and Africa. Dr. Stejneger's paper was illustrated by charts, diagrams and maps, showing the classification, the structural taxonomic characters, probable evolution and geographic distribution of the Amphisbænoid lizards. The chair, Drs. L. O. Howard, C. H. T. Thownsend, General Wilcox and others took part in the discussion.

The last paper of the evening was by W. L. McAtee: "Sketch of the Natural History of the District of Columbia." Mr. McAtee gave a very interesting historical account of the study of the natural history of the District of Columbia from the earliest accounts of Capt. John Smith who ascended the Potomac River as far as Little Falls and made notes on the fauna of the region; and the account of other early explorers and travelers, down to recent times. The speaker gave many entertaining quotations from the writings of these early naturalists, told about the early societies interested in the natural history of the District, and described the faunal and floral lists that have appeared, mentioning the number of species in each, and calling attention to the fact that the District of Columbia is the type locality for many species. Mr. McAtee's communication was discussed by the chair, Dr. L. O. Howard, D. E. Lantz and Wm. Palmer.

M. W. Lyon, Jr.,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 488th meeting of the society, held October 13, 1915, jointly with the Medical Society of the District of Columbia, Dr. Aleš Hrdlička read a paper on "The Evolution of Man in the Light of Recent Discoveries and its Relation to Medicine." Human evolution is now an accepted doctrine in natural history. In addition to the older evidence in the analogies between man and other mammals, the resemblances in embryonic development, the presence of vestiges or reversions, and the like, in recent years a large series of prehistoric remains have completed the demonstration. The evidence is conclusive, although there are as yet important gaps in the line, especially relating to the earlier periods. Among recent changes in man's "evolution" are deterioration of the teeth and disharmonies in the facial structure. Parts which become less useful are eliminated or weakened and degenerated. Progressive and retrogressive changes that are not harmonious or beneficial necessitate medical or surgical intervention. The erect posture results in greater disorders, as in pregnancy. The great enlargement of the brain results in imperfections. The ability of procreation is adversely affected. The study needs the enlightened help of all branches of medicine.

Daniel Folkmar,
Secretary

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